

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

REPORT

ON A PART OF

NORTHERN ALBERTA,

AND PORTIONS OF ADJACENT DISTRICTS OF

ASSINIBOIA AND SASKATCHEWAN,

EMBRACING THE COUNTRY LYING SOUTH OF THE NORTH SASKATCHEWAN

RIVER AND NORTH OF LAT. $51^{\circ} 6'$, BETWEEN LONG. 110°

AND $115^{\circ} 15'$ WEST.

BY

J. B. TYRRELL, B.A., F.G.S.



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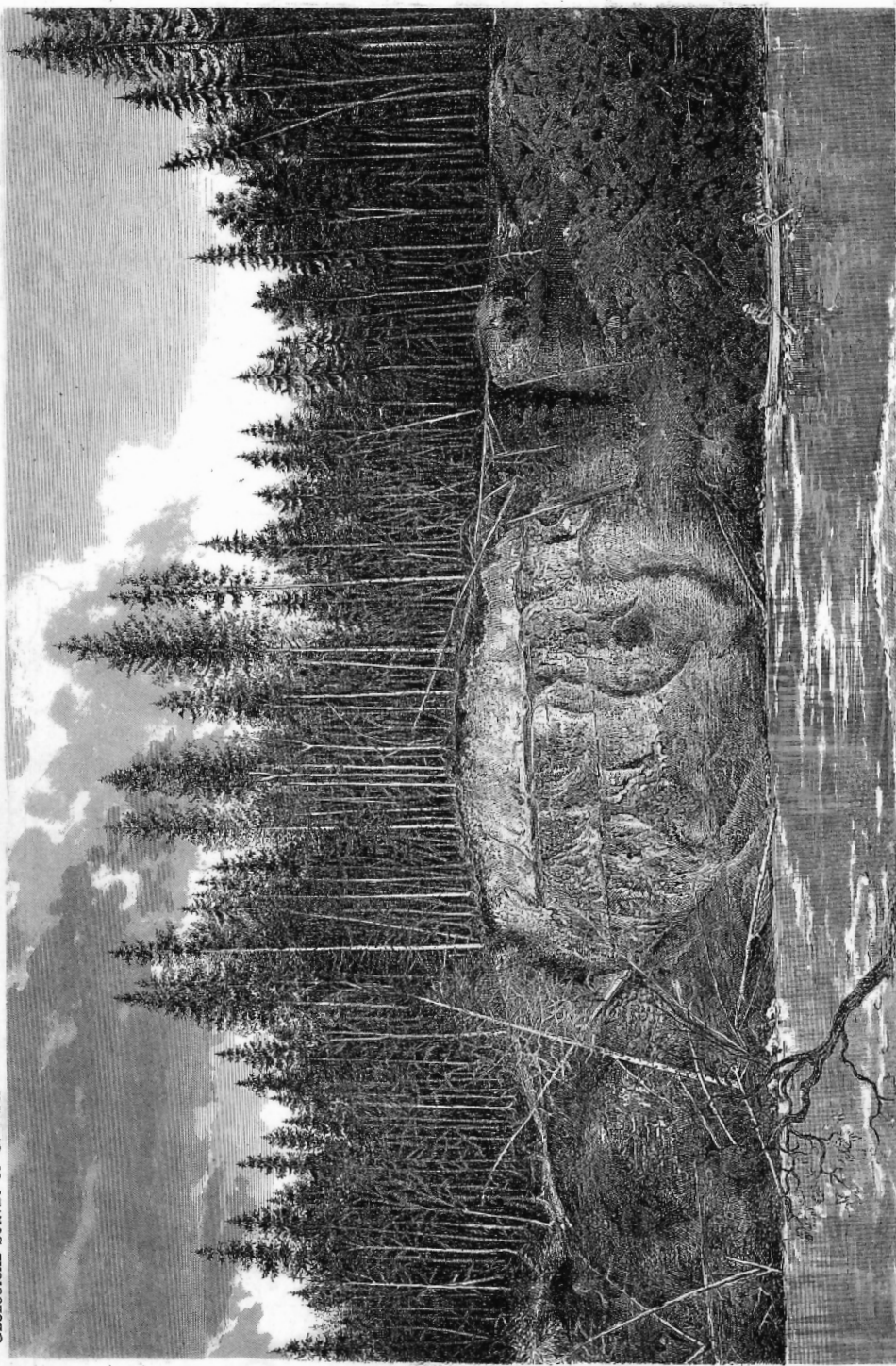
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1887.

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J. B. Tyrrell, Photo., Sept. 1886

THICK COAL SEAM NORTH SASKATCHEWAN RIVER.

45 MILES ABOVE EDMONTON

Mortimer, Lith.



TO ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S.,

Director of the Geological and Natural History Survey of Canada.

SIR,—I beg herewith to submit a report, with illustrative maps, on the geology and natural resources of part of Northern Alberta, and the western portions of the Districts of Assiniboia and Saskatchewan. Although to a certain extent preliminary, and by no means exhaustive in its nature, on account of the short space of time in which it was necessary for me to examine so large a tract of country, this report will, it is hoped, serve as a sufficient guide, for the present at all events, to point out the extent, position and character of the mineral wealth of the district.

I have the honour to be,

Sir,

Your most obedient servant,

J. B. TYRRELL

OTTAWA, 1st June, 1887.

NOTE.

The elevations given throughout this report are partly those determined instrumentally by the engineers of the Canadian Pacific Railway, partly those given in the "Report on the Canadian Pacific Railway, 1877," (old location) which have also been determined instrumentally, wherever it has been possible to fix the point to which the elevation there given refers, but for the most part they have been determined by readings taken with a mercurial barometer and two aneroids in 1886, with two aneroids in 1885, and with one aneroid in 1884, compared with readings taken regularly by the Meteorological Service at Calgary, Medicine Hat, and Edmonton. The heights of the first two of these three places have been fixed from the railway survey, while the height of the cistern of the barometer at Edmonton is taken as 2210' feet.

The bearings are everywhere given with reference to the true meridian.

The invertebrate fossils have been determined by Mr. J. F. Whiteaves of this Survey; descriptions and figures of the new species here mentioned being given in his "Contributions to Canadian Palæontology, Vol. I., Part 2," while for the determination of the plant remains, I am indebted to the kindness of Sir J. W. Dawson of Montreal.

Our thanks are also due to Capt. E. Deville, Surveyor-General of Dominion Lands, and to the officers under him, as well as to Mr. G. U. Ryley, Clerk of Timber, Mineral and Grazing Lands, for placing plans of all the surveys made within the district at our disposal, also to Mr. Charles Carpmal, the Director of the Meteorological Service, and to the observers at Calgary and Edmonton, for the barometer readings taken by them during 1884, 1885 and 1886.

REPORT

ON A PART OF

NORTHERN ALBERTA,

AND PORTIONS OF THE ADJACENT DISTRICTS OF

ASSINIBOIA AND SASKATCHEWAN.

The district described in the following report, and embraced in the map which accompanies it, lies between the 51st and the 54th parallels, north latitude, from longitude 110° to $115^{\circ} 15'$ west, including an area of over 45,000 square miles, the greater part of which is situated in the northern portion of the District of Alberta; but the western edge of both the districts of Assiniboia and Saskatchewan has been included, as it is generally impossible to make natural geological boundaries coincide with political ones. The area is drained in its southern portion by the Red Deer River and the tributaries which flow into it, and in its extreme south-western corner by the Ghost River and a few small streams which likewise flow into Bow River, all which waters find their way into the South Saskatchewan. In its northern portion it is drained by the North Saskatchewan with its tributary Battle River, and by the other smaller streams which join these two main waterways.

Region covered
by report
and map.

Rivers draining
the area.

The three different kinds of country commonly found in the West, namely, prairie, partly wooded country, and forest, are represented within the limits of this district. Of these the two former constitute the greater part of the surface, while the area of forest is small, consisting only of the Beaver Hills and the district stretching south-westward from Edmonton, south of the Saskatchewan and west of the Pigeon and Battle lakes, and within the disturbed region of the foot-hills shown in the south-western corner of the map, though small patches of thickly wooded country may occur here and there in the half-wooded area. The prairie or Great Plains here find their north-westerly boundary, which latter may be defined in general terms as follows:—Beginning ten miles west of Calgary at the Bow River, thence north

Three kinds
of country.

Forest area.

of prairie.

Partly wooded
country.

thirty-five miles to the Morley Edmonton trail, along this trail to the Lone Pine, then on a bearing averaging about twenty degrees north of west to the easterly limit of the map. South of this line lies the wooded district north of the Neutral Hills, which may be regarded as a sort of outlier of the half-wooded country towards the northern edge of the plains. With the exception of the small forest areas mentioned above, the rest of the region consists of half-wooded country, with groves of poplar and willow, separated by open glades and grassy stretches of greater or less extent. This part is thus most attractive, both to the traveller in search of natural beauties and to the would-be settler looking for a place where to make for himself a comfortable home in the shortest possible time.

Ranching
country to the
south.

The region to the south had already been explored, and its main geological and topographical features clearly shown by Dr. G. M. Dawson in the Geological Survey Report for 1882-84. Its capabilities as a ranching country have now been proved beyond dispute by experiment. But it was felt that something more should be known of the great region lying to the north of this essentially ranching district; the great fertility of which as an agricultural country has already been pointed out by Dr. Selwyn, Prof. Macoun and many others who have travelled through it, while the deposits of coal in it seem to be practically inexhaustible. Especially towards the north, however, the country is thickly covered with drift deposits, through which very few streams cut down to the underlying rocks. Added to this, its generally wooded surface so completely shuts off the view for any considerable distance, that it would be impossible to make out some of the minute details of the geology without examining the country foot by foot and, in some cases, even without boring, either of which would require a much longer time than I had at my disposal.

Difficulty of
geological
exploration.

Geographical
basis of map.

I have taken as a geographical basis in the preparation of the accompanying map, the surveys made by the Dominion Lands Department. The surveyors employed by that Department have instrumentally run east and west base lines, and meridian township-outlines, through the greater portion of the district, and subdivided the townships in the vicinity of settlements, as well as traversed the Red Deer, Battle and North Saskatchewan rivers through subdivided townships. Mr. Doupe, one of the surveyors, has also made an excellent micro-meter traverse of the last-mentioned river from Rocky Mountain House to the western limit of the subdivided country. The upper courses of the Red Deer and Clearwater rivers are laid down from plans of timber limits filed in the Government Timber Office in Ottawa.

The distinctive character and contour lines of the hills and lakes, ^{Methods of survey.} and the courses of the rivers outside the subdivided country in the more open districts, have been laid down from odometer surveys made by myself in 1884, by Mr. H. Hamilton, my assistant, in 1885, and by Mr. D. B. Dowling, my assistant, in 1886, and from canoe traverses made by myself in all three years, while the topography of the Beaver Hills and other thickly wooded tracts have been plotted from track-surveys made by myself, the bearings being taken with a prismatic compass, and the distances estimated chiefly from the time occupied on each course, checked by latitudes taken with a sextant of seven-inch arc.

The names employed are chiefly those found on Hector and Palliser's ^{Names employed.} map of 1863, or on the Dominion Land map of 1886; but when others have been considered necessary, those used by the Cree Indians or English translations of them, have been inserted; or if, as in some cases, these names would have led to confusion with other places not far distant, liberty has been taken to apply such new ones as may be thought appropriate

FORMER EXPLORATIONS.

Of the earlier explorations of this region, the first of which any ^{Earliest explorers of the region, 1750.} record remains was sent out by M. Bigot, the Intendant, and de la Jonquière, the Governor of Canada in 1750, under the command of M. Legardeur de Saint-Pierre, to find a route to the western sea by the Saskatchewan River, which had been discovered and ascended as far as the Forks by one of the sons of M. de la Verendrye in 1748. Both M. de Saint-Pierre and his lieutenant, M. Boucher de Niverville, were overcome by the difficulties of the journey, and obliged to turn back, but some of their men pushed on and succeeded in reaching the mountains, where they founded Fort La Jonquière in 1751, at a distance, as ^{Fort La Jonquière.} stated by M. de Saint-Pierre, of 300 leagues beyond Fort Paskoya, on the Paskoya (or Saskatchewan) River, near the mouth of Carrot River.

I am unable to find out whether these men ascended the north or the south branch of the Saskatchewan above the Forks, but it is probable that they followed the north branch, as the Indians along its banks belonged to the friendly tribes that had been known for some time around Lake Winnipeg, while the tribes on the plains to the southwest were always understood to be very fierce and hostile.

At all events, as these intrepid voyageurs were the first to reach the Rocky Mountains in Canadian territory, the expedition is worthy of notice, even though their route and the position of the fort founded by them be undeterminable.*

The next expedition of which I find any mention, is that of Mr. Fidler, whose route is laid down on Arrowsmith's map of North America, 1811. He started from old Fort George, which was situated on the north branch of the North Saskatchewan River, four and a half miles above the mouth of Moose Creek, in 1792, and travelled in a south-westerly direction, crossing the Battle, Red Deer and Bow rivers, reaching apparently as far south as the Little Bow River, or Willow Creek, near the base of the mountains. In 1793 he returned to the Saskatchewan, by a route a little east of the one that he had followed going out, crossing the Red Deer at the mouth of Rosebud Creek, which he calls "Edge Coal Creek," opposite which the following note is written on the face of the map: "Great quantity of coals in this creek." With the exception of the coal-seam mentioned by Sir Alex. Mackenzie as having been seen by him on Great Bear River in 1789, this is the first record of the discovery of coal in the Canadian North-West Territory.

Fidler, 1792.

First record
of coal in the
N. W.

But one of the most indefatigable of the early explorers was Mr. David Thompson, an officer of the North-West Fur Trading Company, who at the close of the last and at the beginning of the present century, travelled and traded throughout the country between Lake Superior and the Pacific. An enthusiastic geographer, neither the adventures of the journey nor the business of trade, hindered him from making a survey of some kind, of the route he was traversing, or when remaining at a post or "House," of determining, as far as possible, its true position by numerous astronomical observations, and it is much to be regretted that the results of his work have, up to the present, remained almost entirely in manuscript.

D. Thompson,
1798-1807.

From his field note-books, which the Crown Lands Department of Ontario has kindly allowed me to consult, the following notes with regard to his travels have been hurriedly gathered:—

Journeying westward in the autumn of 1798, he called at Fort George on his way to Lac La Biche, and in the spring of 1799 spent a few weeks at Edmonton, then known as Fort Augustus, before going north to the Athabasca River and Isle à la Crosse. In March, 1800, he made a hasty survey of the trail then used on the south side of the river, between Fort George and Edmonton, and on the fourth of May embarked at Rocky Mountain House and descended the Saskatchewan in a boat, reaching Fort George on the twelfth of May, and the Grand Rapids, at the mouth of the river, on the sixth of June, making an

His
explorations.

*Les Varenne de Verendrye, by Pierre Margry in *Revue Canadienne*, 1872. *Mémoire ou Journal de Legardeur de Saint-Pierre*, in the Canadian Archives Office in Ottawa, and published in "Report of Canadian Archives by Douglass Brymner, archivist, 1886. Ottawa, 1887.

excellent track-survey for the whole of the distance. He saw the out-crop of the "Big Coal-Seam," but as its face had crumbled down and was largely covered with wet earth, he speaks of it as "crude bitumen mixed with earth" oozing out of the bank about eight feet above the surface of the water. In October of the same year, he started on horse-back from Rocky Mountain House, and taking the trail up the west side of Clearwater River, reached the Red Deer, which he followed for a considerable distance into the mountains to a large camp of Kootanie Indians, whom he induced to return with him to the "House." On the seventeenth of November he again set out for the south, and came to the Bow River, not far from the present site of Calgary, continuing along its banks in a direction a little south of east as far as the mouth of Spitchee or High River, where a large band of Piegiens had pitched their camp. After spending a few days in establishing friendly relations with these Indians, he turned back and followed the Bow River a short distance into the mountains, and then struck northward from about the vicinity of Morley to Rocky Mountain House. In the summer of the same year Duncan McGillivray, apparently acting ^{Thompson's} ^{explorations.} under Thompson's instructions, and starting from the Post last mentioned, followed the Saskatchewan to its source in a small lake in the mountains, and even crossed the summit and descended a short distance down Blaeberry River. ^{D. McGillivray}

In 1801, Thompson made a track-survey of the route between Rocky Mountain House and Edmonton, apparently following a trail which led south of Gull Lake, and finally, in 1807, he left Rocky Mountain House.* He followed the Saskatchewan to its source in the mountains, and crossing the summit in latitude $51^{\circ} 48' 25''$ on his way to the west coast, descended to the Columbia, down a stream which flows into the latter in latitude $51^{\circ} 30'$, evidently the Blaeberry River.

In 1814, Gabriel Franchère left Fort George or Astoria, at the mouth ^{G. Franchère,} ^{1814.} of the Columbia River, and crossed the mountains by the Athabasca Pass; then travelling by way of Athabasca River and Lac La Biche, he reached the Saskatchewan near the mouth of Dog Creek, a short distance above Fort George. From this point he descended in a canoe to Lake Winnipeg, which he reached on the twenty-fifth of June, having been two months and twenty-one days from the Pacific coast.† Though there is nothing of geological interest in his narrative, it

* There were, in the North-West Territory, three trading-posts which commonly went by the name of Rocky Mountain House, one on Peace River, also known as Hudson's Hope; one on the Athabasca, now generally known as Jasper House, which was a supply post on the old traders' route through the mountains, and described by Ross Cox, Franchère, and others of the older travellers, and the post on the Saskatchewan, near the mouth of the Clearwater, which is marked as Acton House on some of the older maps. The third only is so named in this report.

† Narrative of a Voyage to the North-west Coast of America, in the years 1811, 1812, 1813 and 1814, by Gabriel Franchère. English Edition, New York, 1854.

abounds in lively descriptions of the country passed through, and of the manners of the native tribes with whom he came in contact, more especially, however, those on the western side of the mountains.

T. Drummond,
1825,

In the summer of 1825, Thomas Drummond, assistant naturalist in Franklin's second overland expedition,* ascended the Saskatchewan as far as Edmonton on his way to the mountains, and in the spring of 1827 returned east along the banks of the same river, collecting specimens of plants and animals, which were afterwards described by Sir Wm. Hooker and Sir John Richardson.

D. Douglass,
1827.

In this latter year, David Douglass† crossed the mountains from British Columbia by the Athabasca Pass, and reaching the Saskatchewan at Edmonton also descended it on his way east, being engaged, like Drummond, in collecting botanical and zoological specimens.

Sir G. Simpson,
crosses the
N. W., 1841.

In the summer of 1841, Sir George Simpson,‡ Governor of the Hudson's Bay Company, crossed the northern and western portions of the district on his journey across the continent. Turning to the south side of the Saskatchewan at Fort Pitt, he followed, as far as we can learn from his narrative, the trail travelled also by Dr. Hector in the spring of 1859; passing the "chair of lakes" at the source of Vermilion River, and going north of the Beaver Hills, he reached Edmonton on the evening of the fourth day from Fort Pitt. From Edmonton he directed his course more to the south, camping on the first night at Smoking Weed Creek, now known as Pipestone Creek, and on the second by the shore of Gull Lake. After fording Blind Man River, he reached Reedy Lake, probably "Swan Lake," beyond which he passed over the ridge of hills to the south-west, and following the wide open valley of Medicine River, crossed the Red Deer at the old ford, and thence directed his course to the cañon on the "La Biche" or Little Red Deer River. Here he turned westward, sometimes tracking up the river, and sometimes wading through deep swamps, till he reached the Devil's Lake Gap, where he entered the mountains. His narrative is very racy, and deals rather with the incidents of the journey than with the country passed through. In giving a short account of Edmonton, however, he mentions the occurrence of coal in the river banks close to the town, and though the thickness of the deposit is greatly exaggerated, it is one of the first notices that we have of the existence of coal on the Saskatchewan.

First notices
of coal on the
Saskatchewan.

Sir John Richardson, in 1851, makes the following mention of the presence of coal in the same locality: "Mr. Drummond procured me

* Narrative of a Second Expedition to the Shores of the Polar Sea, by John Franklin, Capt. R. N., pp. 303-313.

† For an account of the wanderings of David Douglass in America, Hooker refers to the "Companion to the Botanical Magazine, vol. II.," which, however, to me has been inaccessible.

‡ Narrative of a Journey round the World, by Sir Geo. Simpson, London, 1847, vol. I. pp. 97-114.

specimens of coal with its associated rocks at Edmonton, on the north branch of the Saskatchewan," and "clay ironstones occur in the clay beds" which are found in the same section with the coal seam. He considers these beds, with the coal-bearing horizon on the Mackenzie River, as of Tertiary age.*

In the autumn of 1845, Father De Smet came across the Rocky Mountains from British Columbia through the White Man's Pass, reaching first Rocky Mountain House, and then Fort Augustus or Edmonton. From the mouth of White Man's Pass he appears to have ascended Bow River, crossed over to the Red Deer and probably afterwards to James River, following the old trail down this stream till it crossed to the Clearwater, down which he turned to the Mountain House. In his account of the journey, he speaks of seeing coal on one of the branches of the Red Deer "apparently very abundant," adding "that it abounds east of the mountains on the Saskatchewan and Athabasca." It is probable that the former remark refers to a coal-seam which is reported by the Indians as cropping out on James River, inside the area of the foot-hills.*

But by far the most interesting and important expedition which has visited and explored this district, was that sent out by the British Government under the command of Capt. Palliser, assisted by Capt. Blackiston, with Dr. Hector as geologist, and M. Bourgeau as botanist.

In the summer of 1857 the expedition reached Fort Carleton, whence Capt. Palliser returned east for the winter, while Dr. Hector went on as far as Rocky Mountain House with a dog-team, travelling overland on the journey up and returning on the river. In the spring of 1858, after the arrival of Capt. Palliser, the whole party set out from Carleton, and after rounding the Elbow of the Saskatchewan, kept a course almost due west, crossing Battle River a little below and again a little above the Elbow, and passing south of Buffalo Lake, across Tail Creek and Red Deer River, reached a point on Rosebud Creek, where they split up into four smaller parties. Capt. Palliser kept to the south, spending the rest of the summer on the plains or in the mountains beyond the limits of the present map, returning to Edmonton on the 20th of September. Dr. Hector turned west to the Old Bow Fort, and then into the mountains, coming out by the Saskatchewan from Rocky Mountain House, keeping the winter trail by the north end of Gull Lake to Edmonton, which he reached on the 7th of October. Capt. Blackiston went south to explore the North and South Kootanie Passes, while M. Bourgeau went west into the mountains in search of

* Journal of a Boat Voyage through Rupert's Land, p. 195.

* Oregon Missions by Father P. J. De Smet, New York, 1847, pp. 153-160.

Explorations
by Dr. Hector.

plants. On the 22nd of October, Hector started on a nine days' exploring tour down the Saskatchewan, and on the 26th of November undertook an excursion to Ghost River, taking what is now the Edmonton-Calgary trail to the mouth of Blind Man River, then after following up the Red Deer River for a considerable distance, turned south to Little Red Deer River, entering the foot-hills at the cañon on this stream, which he followed up to Prairie de la Graise, across which he passed to Ghost River. On the return trip he followed the old trail which crosses Dog Pond Creek at its mouth, and Red Deer River a short distance below the confluence of the Little Red Deer, reaching Edmonton again on Christmas-eve. The rest of the winter was spent by him in making an excursion to Jasper House, on Athabasca River, while Capt. Palliser remained in the vicinity of Edmonton and Rocky Mountain House hunting buffalo and making what arrangements were necessary for the next season's work.

Map of the
North-west.

In the spring of 1859, Dr. Hector, who had gone down to Fort Pitt to attend to a number of cases of sickness there, returned to Edmonton, making an odometer survey of the trail followed, and then this expedition started south to the Hand Hills, and thence, first south and then west, across the mountains into British Columbia, returning to England from the west coast. This exploration furnished us with the first serviceable map of the North-West Territory, and from a geological standpoint, it showed the existence of a great coal-bearing area of Cretaceous and Tertiary rocks extending from the Laurentian axis on the north-east to the Rocky Mountains on the west, and in a paper published in the *Edinburgh New Philosophical Journal* for October, 1861, Dr. Hector first recorded the occurrence of gold in the Saskatchewan.*

Later
explorations.

Succeeding explorations are too well known to require more than a passing notice here; especially as most of them followed closely the banks of the Saskatchewan, and added very little to our previous knowledge of the country, the two exceptions being those of Dr. Selwyn and Prof. Macoun, both of which will be found mentioned later on in this report.

Earl Southesk,
1859.

In the summer of 1859 the Earl of Southesk, impelled by a desire for novelty and a love of sport and travel, crossed this district on his way to and from the mountains,† and in 1863 Lord Milton and Dr. Cheadle followed up the North Saskatchewan as far as Edmonton, on their way to the gold regions of British Columbia.‡

Milton and
Cheadle, 1863.

*For full account of this expedition, see "The Journals, Detailed Reports and Observations relative to the Exploration, by Captain Palliser," with accompanying "Index and Maps." Government, London, 1863.

† "Saskatchewan and the Rocky Mountains," by the Earl of Southesk. Edinburgh, 1875.

‡ "The North-West Passage by Land," by Viscount Milton and W. B. Cheadle, M.A., M.D., &c.

In the autumn of 1870, Capt. Butler was sent out by Governor Archibald of Manitoba to establish some civil authority in this western district, and to enquire into the cause and extent of the ravages of small-pox among the Indians. He reached as far west as Rocky Mountain House, returning to Manitoba before the end of the same year.*

In 1873, Dr. Selwyn travelled from Fort Garry to Rocky Mountain House and back. Leaving Fort Pitt on the 31st of August, he followed the trail on the north side of the river to Edmonton, where he crossed the Saskatchewan and followed the Hudson's Bay Company's cart trail to Rocky Mountain House. Here he secured a boat from the officer in charge at the fort, and descended the Saskatchewan to its mouth, making a track-survey of the course of the river, as well as a geological examination of its banks. Besides a number of interesting observations on the horizons of the different beds seen in the course of the journey, he was the first to record the existence of the "Big Coal-Seam" outcropping near Goose Encampment, about half-way between the mouth of Brazeau River and Edmonton, as well as to recognize the great extent of the coal deposits over the surrounding area.†

In 1875, Dr. R. W. Ellis, who was in charge of the boring operations carried on at Fort Carleton, descended the Saskatchewan from Rocky Mountain House to the above fort, collecting specimens of the economic minerals of the country for the Centennial Exhibition at Philadelphia,‡ and in 1879 Dr. Dawson and party passed through the district on their way east, after the examination of the Peace River Pass.§

In the same year, Prof. Macoun crossed the plains in a south-westerly direction from Battleford to the Hand Hills, touching on his way the south-east angle of Sounding Creek; then, fording the Red Deer, he went on to Blackfoot Crossing, and thence west to Morley, while his assistant, Mr. Wilkins, turned north to Tail Creek, then east past the Neutral Hills and Sounding Lake to Battleford. From Morley Prof. Macoun followed the old trail north to a distance beyond Leavings on Battle River, when he turned to the north-east towards Hay Lakes, and then a little south of east past Flag Hill, across Battle River, and passing to the north of the wooded rolling hills, reached Fort Pitt and the Sounding Lake trail, which he followed north for a short distance, and then turned east towards Battleford, being the last on the list of explorers who traversed that country before the Canadian Pacific Railway provided an easy means of access into it, making the journey from Winnipeg a matter of a few hours only, instead of several weeks as formerly.

Capt. Butler,
1870.

Dr. Selwyn,
1873.

Dr. Ellis, 1875.

Dr. Dawson
1879.

Prof. Macoun,
1879.

* "The Great Lone Land," by Capt. W. F. Butler. London, 1873.

† Geol. Survey Report for 1873-74, pp. 17-65.

‡ Geol. Survey Report for 1785-76, pp. 287-289.

§ Geol. Survey Report for 1879-80.

GENERAL PHYSICAL FEATURES.

General
character of
the country.

The general character of the country is that of a sloping plain, breaking into abrupt ridges to the south-west, where a small area of foot-hills is included. From the base of these hills, which attain a height of 5000 feet above sea-level, the country declines to the north-east, sloping off from an altitude of 4000 feet, along the eastern edge of the foot-hills, to 1650 feet at Fort Pitt, on the Saskatchewan. The slope, though fairly regular, taken as a whole, is, however, broken by numerous high hills and deep river channels. These latter follow the general direction of the present slope of the country till they get beyond the edge of the compact sandstones of the Upper Laramie, when they turn to the east or south-east, the North Saskatchewan being again, however, diverted to the north by the more thickly drift-covered region of the Beaver Hills, while the Red Deer turns almost due south, adopting the channel down which Trail Creek flows from Buffalo Lake, its direction in this southerly stretch being slightly opposed to the general inclination of the country.

Principal hills
and their
altitudes.

Of the hills which rise above the surrounding level, the principal ones are the Hand Hills, which form an irregular plateau 3550 feet above sea-level and more than 1300 feet above the Red Deer River at their base, with a gentle prairie slope to the east and an abrupt escarpment towards the west. On the opposite side of the Red Deer, Wintering Hills attain a height of 3225 feet, faced by a steep escarpment towards the north-east, and falling off gradually to the plain on the south and west. The Neutral Hills are high, broken ridges rising westward to the "Nose" to an elevation of 2970 feet, while to the north the country is, to a large extent, made up of rolling, sandy ridges, partly wooded with aspen, with intervening valleys which are dotted with fresh water lakes. North of Battle River the Blackfoot Hills, 2400 feet in height, are seen as rolling, lightly-wooded ridges. The Beaver Hills, south-east of Edmonton, with an elevation of 2500 feet, are densely-wooded, sandy ridges, separated by wide marshes, or "beaver meadows," made by beavers, that have dammed back the small streams which run out from among the hills. Besides those already mentioned, the following are conspicuous and important land-marks: Knee Hills, 3075 feet; Three Hills; Surcee Butte, 3005 feet; Antler Hill; Flagstaff Hill; Peace Hills, 3600 feet; Bear Hills; Medicine Lodge Hills, 3500 feet; Hawk Hill; Nose Hill, 3900 feet; Big Hill, 4250 feet, and, as we approach the mountains, numerous ridges, which often rise in places to a considerable height, cross the country in a north-westerly and south-easterly direction.

Lakes, however, as well as hills, are numerous and form conspicuous ^{Lakes.} natural features. Some of them, which lie in the western and more thickly-wooded part of the district, have outlets carrying off a considerable quantity of water, but many others, which lie on the impervious clays of the Edmonton series, are merely evaporating basins, either now without an outlet or with one which carries water only in seasons of flood. The latter are generally more or less alkaline, and often of a milk-white colour from suspended clayey matter. Among them, however, a few, such as Beaver Lake, have outlets with running water all the year round.

The following is a list of some of the more important lakes, with ^{Elevations.} their approximate elevations :—

	FEET.
Egg Lake (near Victoria).....	1997
Birch Lake.....	2140
Sounding Lake.....	2140
Beaver Lake.....	2178
Wavy Lake.....	2260
Hastings Lake.....	2380
Cooking Lake.....	2400
Buffalo Lake.....	2536
Dowling Lake.....	2563
Sullivan Lake.....	2620
Bear Lake.....	2624
Pigeon Lake.....	2824
Battle Lake.....	2770
Quill Lakes.....	2860
Little Fish Lake.....	2890
Gull Lake.....	2905
Devil's Pine Lake.....	2910
Buck Lake.....	2970
Egg Lake (in Hand Hills).....	2970

The division of the country into the three classes mentioned above, namely, plains, half-wooded country and forest, is perhaps the most convenient classification that can be adopted for general descriptive purposes, though it will be of no service when we reach the essentially geological part of the report, and even here only serves to distinguish more or less indefinite areas.

The Great Plains occupy the southern and south-eastern portion of ^{The Great Plains.} the district. West of Red Deer River they are broken by deep, often wooded, valleys, while to the east of the Red Deer and beyond the Hand Hills, they stretch away in a lightly rolling, grassy sward, unbroken by either high hills or deep valleys, and no wood is any where to be seen, except a few willows on two of the more sheltered

creeks. The greater part of the soil is eminently fertile, and would produce all the ordinary cereals and root crops grown in eastern Canada. The want of trees might be felt for a time, but thrifty settlers would soon re-establish the groves which prairie fires, rather than drought or frost, have kept down, for there is every reason to believe that many of the hardier kind of trees would grow even on the more exposed parts of the prairie if they were preserved from destruction by fire. The timber or lumber needed immediately for building purposes can be floated down the Red Deer at small cost, and wood is not needed for fuel, as the supply of coal in the vicinity is practically inexhaustible. Good water can also be obtained almost everywhere, either in the brooks which drain the country or in the small lakes scattered over its surface.

Good grazing country.

Though much of this part of the plains is, as we have seen, well adapted for agriculture, yet it is especially valuable as a grazing country, for the ground in winter is never covered with more than a few inches of snow, and the valleys, though shallow, are deep enough to protect herds against the storms.

Partly wooded country.

More to the northward, clumps of willow appear, and a little further on, groves of poplar occur around the lakes and on the northern slopes of the hills, spreading out in places so as to cover areas of considerable extent. We have now reached the partly wooded country. The soil has become richer and deeper, and, instead of the short buffalo-grass of the plains, the grass is longer and mixed with a thick growth of vetch and pea-vine (*Astragalus*, *Vicia* and *Lathyrus*), forming excellent pasture. This partly wooded country, lying between the Great Plains to the south and the forests to the north, has for many years attracted the favourable notice of travellers, and is even yet best known to many by the name "Fertile Belt," which was given to it by Dr. Hector in 1861.

The "Fertile Belt."

Forest area.

The forest area included in the district under consideration stretches along its western edge, with the Beaver Hills as an outlier. The surface is, for the most part, very uneven, consisting of high, sandy ridges covered with spruce and "cypress" or jack pine (*Pinus Murrayana*), some balsam, fir and birch being also found in the more northern parts.

Between these ridges are wide, marshy tracts, either covered with moss and forming impassable "muskegs," or bearing a thick growth of spruce and larch, through which it is equally difficult to travel. Some of these valleys, if cleared and drained, would doubtless furnish good agricultural land, though it is hardly likely that the necessity for cultivating them will be felt for some time to come. On the uplands much of the spruce is of excellent quality, and will, before long, be a source of considerable wealth to the country.

TRIBUTARIES OF BOW RIVER FROM THE NORTH.

The Bow River has already been described by Dr. G. M. Dawson in his "Report on the Region in the Vicinity of the Bow and Belly Rivers."* In the summer of 1881 he descended it in a canoe from Morley to its mouth, and on other occasions examined its valley from Morley to its source in the heart of the mountains. It remains, then, for us briefly to describe some of the small streams which flow into it from the north, draining but an inconsiderable area in the south-western corner of the district.

Dr. Dawson's
Report.

Ghost River, the largest of these streams, is a clear, rapid torrent, eighty feet wide just above its mouth, and at high water from five to six feet deep. It rises on the eastern flank of the outer limestone range of the mountains, and flows eastward over a wide bed of quartzite pebbles through a country thickly covered with small spruce and *brulé*. The upper part was examined in 1883 by Dr. G. M. Dawson as far east as a point lying north of Old Bow Fort, on the Bow River, the banks at that point being high and wooded.

Ghost River.

Along the river down to its junction with the Bow, a distance of eleven miles, high gravel terraces are seen in the valley, those to the north being prairie-like and covered with excellent bunch-grass, those to the south being for the most part covered with windfall.

Between Ghost and Bow rivers, the country consists of irregularly rolling, partly wooded hills, with beautiful stretches of fertile land in the bottoms of the valleys and on the sloping hill-sides. These are covered with excellent grass, which is often mixed with *astragalus*, wild vetch, and other leguminous plants which represent clover in the west, making one of the finest ranges for horses and cattle in the Territory.

Grazing land
between Ghost
and Bow rivers.

North of Ghost River the country is of a much more regular character: high ridges, partly timbered, running in a north-westerly direction, separated by low, generally swampy valleys, down which larger or smaller brooks flow to join the main stream. One of these, known as the North Fork, and also rising in the outer range of the mountains, is of about equal size with the principal branch of the river which it joins seven miles above its mouth.

Country
further north.

From the mouth of Ghost River to the edge of the disturbed belt, as outlined on the map, three small streams flow into Bow River, draining as many wide, sloping and, in places, rather marshy valleys. A little to the east of these again, two similar brooks flow in deep, narrow valleys, from one hundred and fifty to three hundred feet below

* Geological Survey Report for 1882-84, pp. 29 c. et seq.

the surrounding plateau. The area drained by these creeks, and the country stretching east as far as the "Nose," are covered with good bunch-grass, wood is also plentiful in the deeper parts of the valleys and on sheltered hill-sides—in fact, wood, water and grass are here in abundance, and plenty of coal can be had from the seam which crops out near the mouth of Coal Creek.

Big Hill Creek. Big Hill Creek, the most easterly and largest of these five creeks, for four or five miles north of the Morley-Calgary trail runs in a valley from two to four hundred feet deep, and about half a mile wide at the top, the banks in some places being grassy, in others covered with poplar of fair size. The Big Hill, which lies south-east of this creek, between it and Bow River, is a high, rounded mass, doubtless of hard sandstone, rising 550 feet above the river at its base, its southern and western sides being covered with a thick growth of large and small poplar. From the Big Hill eastward, a high ridge runs north of Bow River, culminating in the "Nose," a round grassy hill, 500 feet high, lying five miles north-west from Calgary. This ridge is rolling, and broken here and there by small lakes and marshes, from which a large quantity of hay is now regularly cut.

Nose Creek. East of the "Nose," Nose Creek flows south into Bow River, receiving on the way a branch from the west. It is a small, clear stream, twenty-five feet wide and one foot deep at low water, flowing in an open, treeless valley a quarter of a mile wide and eighty feet deep at its mouth, but becoming wider and shallower towards the north. In the flats near the mouth the soil is good sandy loam, which, however, is gradually replaced up-stream by a hard clay. The uplands to the east are sandy, and bear a close growth of short nutritious buffalo-grass.

Watershed between Bow and Red Deer rivers. The watershed dividing the drainage areas of the Bow and Red Deer rivers outside the edge of the foot-hills begins about ten miles north of the Bow, and runs eastward for fourteen miles, crossing the Morley-Edmonton trail at an elevation of 4300 feet; thence it follows a north-easterly course, and crosses the Calgary-Edmonton trail twenty-eight miles north of Calgary, at an elevation of 3600 feet; thence it runs a little east of south along the east side of Nose Creek to "Spy Hill," keeping essentially the same elevation; thence eastward to Strathmore, on the Canadian Pacific Railway, at an elevation of 3005 feet; thence north-eastward around the head-waters of Crowfoot Creek, and thence south-eastward beyond the limits of this district.

UPPER RED DEER AND ITS TRIBUTARIES.

Little Red Deer River.

The Little Red Deer, the most southerly affluent of the Red Deer River in the upper part of its course, rises like the Ghost River in the

outer limestone range of the mountains, a little north of the Devil's Head Mountain, and flows easterly for about nineteen miles as far as the crossing of the Stoney Pack-trail, where it is a clear stream fifteen feet wide and a foot deep. From this point it flows in an east-north-easterly direction for four miles, to the mouth of Tomuna Sipisis, or Grease Creek, through a narrow valley bounded by sandstone ridges, which recede a little in some places and leave room for high terraces. Grease Creek is a stream almost as large as the Little Red Deer, joining it from the north-west, and like it, flowing over a bed of quartzite pebbles. At its mouth, and for half a mile further east, there is a wide, open, grassy flat, the first pasture met with below the trail crossing, the banks being before covered with small spruce and poplar. The Little Red Deer now turns north-eastward for about two miles and a half, in a valley three-eighths of a mile wide, bounded by high, sloping, wooded hills, the bottom, through which the river winds from side to side, being covered with bunch-grass and dotted with groves of aspen and willow. For the next mile the river flows through a narrow gorge or "cañon," with rocky sides from fifty to two hundred feet high, and then turns to the north-east, and for five miles flows in a valley a hundred feet deep and a quarter of a mile wide at the bottom. The flats for the first four miles are well covered with excellent bunch-grass, the stream being bordered by a fringe of willows and poplars, and the sloping sides of the valley wooded with small aspens. For the last mile, however, the flats are swampy and covered with a dense growth of spruce. The valley then turns to the east, retaining this latter character, the bottom being covered with rather small spruce and the sloping banks being either partly wooded or grassed. After running east for four or five miles, it turns abruptly to the north, and for eighteen miles the river flows along the bottom of a valley from one to two miles wide, the sides of which decline gradually from the higher plateaus to the east and to the west, the slopes being partly covered with poplar, with some spruce in the small transverse gulleys, and partly with low willow and birch scrub, under which there is a close grassy sward. The bottom land is often marshy and timbered with good spruce. At the end of this stretch the river turns abruptly to the east, leaving the valley just described,—which however continues on and joins that of the Red Deer about eight miles further north,—and runs for three miles in a narrow irregular valley a hundred feet deep, with steeply sloping sides covered with grass or small poplars. About two miles north of this part of the river is a rounded hill five hundred feet high, and well wooded to the summit. The Crees call it Kihīawātis, or Eagle Hill. After a course of three miles to the east-north-east in a narrow channel bounded to the north by partly wooded terraces, the Little Red Deer

Grease Creek.

Little Red Deer River.

Wide valley.

Eagle Hill.

Dog Pound
Creek.

is joined by the Ko-ma-tasta-moin Sipisis, or Dog Pound Creek, a small clear stream twenty-five feet wide and twenty inches deep, flowing over a bed of quartzite pebbles. This tributary rises in the high ground about twelve miles north of Bow River, a little to the west of the edge of the prairie, the small brooklets collecting into two main branches, which after their junction flow northward for seventeen miles in a sloping valley very similar to the corresponding one further west, occupied by the Little Red Deer, but much more open and grassy, the west side alone bearing timber of any considerable size, the east side being prairie dotted with willow bushes and a few aspen groves.

Lower course
of Little Red
Deer River.

From the mouth of the Dog Pound, the Little Red Deer flows north-east for eight miles to the crossing of the Rocky Mountain House trail, in a valley the sides of which are largely wooded with poplar or small spruce, and the flats often clear and covered with good bunch-grass; it then flows in a winding channel for about fourteen miles to its confluence with the Red Deer, bordered in many places with thick groves of spruce, through beautiful prairie slopes reaching from its edge up to the level of the surrounding country.

Country west
of Little Red
Deer River.

Between the Little Red Deer River and Fallen Timber Creek, the country is made up of a series of longitudinal ridges, running north-west and south-east, for the most part thickly wooded with spruce and poplar. These decrease in height towards the east and are separated by flat, swampy valleys. Further east, between Little Red Deer and Red Deer rivers, a considerable portion of the area is covered with hay-marshes, around which are growing thick groves of poplar, willow, and occasionally spruce. The soil, a rich dark sandy loam, would make excellent farming land when drained, which could be done quite easily.

Rich soil.

Fallen Timber
Creek.

Kow-ich-ti-kow Sipisis, or Fallen Timber Creek, is another affluent of the Red Deer from the south. At its mouth it is a rapid clear stream, thirty-five feet wide and two feet deep, with a bed of quartzite pebbles. It rises in the outer range of the mountains a little north of the source of the Little Red Deer, and flows in a north-easterly direction to the crossing of the Stoney pack-trail. From here it flows a little north of east, being bounded on the south first by high spruce-covered hills and then by low ridges with wide intervening swampy valleys; to the northward are low rolling hills, sparsely covered with a scattered growth of pine, spruce and poplar. At the western edge of range five, west of the fifth principal meridian, the swampy land disappears for a time, the creek, which has here a breadth of twenty feet, running south-easterly for from two to three miles through low dry flats. It then turns abruptly to the north, and after a course of eleven miles flows into Red Deer River. For seven miles from its mouth, it runs

through a marshy valley, which is bounded on the east by conspicuous wooded ridges, and on the west by a wide shingle flat, covered with dwarf birch and willow, and which stretches back to a ridge covered with a dense forest of large spruce.

COUNTRY DRAINED BY STREAMS FLOWING EAST INTO RED DEER RIVER.

Lying north of the watershed line between the Bow and Red Deer rivers, for the most part east of the Calgary-Edmonton trail, and south and west of Red Deer River, is a tract of land about 3400 square miles in extent, drained by several small streams, which flow eastward into the latter river. The highest ridge of this area begins at Spy Hill, north-east of Calgary, with an elevation of 3600 feet, and runs north along Nose Creek to the ridge at its source, retaining essentially the same elevation. From this line as a base the country slopes off to the north and east, the elevation of the Red Deer River at the ferry being 2750 feet, and at the mouth of the Rosebud 2230 feet, which, allowing for the heights of the banks at each of these places, gives an average fall of thirteen and a half feet to the mile east and north from the above-mentioned line.

The district is drained by four main streams, which we will briefly notice in order, from south to north.

Rosebud or Arrowwood Creek rises in some low, marshy lakes a short distance west of the Morley-Edmonton trail, at an elevation of 3450 feet, and flows directly south-east for forty-five miles in a beautiful valley from forty to seventy feet deep and about a quarter of a mile wide. This valley is almost entirely open, with sloping grassy banks, at the bottom of which lie fine grassy flats, though west of the 114th meridian a few poplars and willows are met with here and there on its steeper hill-sides and in lateral coulées running in from the south. Below this meridian, several small streams join it from the west, draining stretches of open, rolling prairie. To the north-east the country is almost level, evenly grassed, with a few small hay-swamps. Near the Morley trail, the prairie on both sides of the valley is somewhat marshy and covered with low willow scrub, under which is growing a close mat of coarse grass, but before the Calgary trail is reached, the willow scrub has quite disappeared, and from there eastward, the country is covered with a good growth of short buffalo-grass.

At the end of this south-easterly stretch the river turns sharply to the east, the banks immediately falling back for a considerable distance, leaving a wide grassy interval, through which the stream winds in a very crooked channel for nine miles. The soil is a fine white silt, contrasting with the dark, sandy loam which covers most of the surround-

ing higher country. To the south-east, a range of low, drifting sand-hills, partly covered with willows and rose-bushes, and separated by small fresh water lakes, breaks with its irregular outline the even contour of the prairie horizon.

Lower course of
Rosebud Creek.

At the eastern end of the wide flat the valley narrows to something like its former width, and continues in an easterly direction for eighteen miles. Its sides are generally grassy, though scarped at a few of the sharper bends, but, instead of being comparatively even as before, they are now broken by numerous coulées, which drain the higher lands on either side. Eight miles below the flat, wood again appears on the banks in the shape of small willows and serviceberry bushes (*Amelanchier Canadensis*), and the stream is blocked by numerous old beaver-dams. For the last seventeen miles before emptying into the Red Deer, the creek flows in an east-north-easterly direction in a valley which deepens rapidly towards its mouth, while the banks become very precipitous and the lateral coulées are filled with a thick growth of spruce.

Country to
the south.

South of Rosebud Creek a high ridge runs east and west, culminating in the Wintering Hills. This is an elevated plateau, 3225 feet above sea-level, with a steep, though generally wooded, escarpment to the north. A level or slightly sloping plain, dotted with many small lakes, occupies the top of the plateau, and to the south it breaks into bare, rolling hills, with lakes in nearly all the intervening depressions; beyond, a plain stretches away to Cranberry Valley. Between the Wintering Hills and Rosebud Creek, the country is a good grassy prairie, dotted with small lakes, and broken by numerous deep and often wooded coulées; while north of the creek the lakes are fewer in number, and the land is drained by a number of coulées falling southward but carrying water only in wet weather.

Knee Hills
Creek.

Knee Hills Creek, which is the next stream met with north of the Rosebud, is made up of two branches which rise respectively near the Lone Pine on the Edmonton-Calgary trail, and south-east of Antler Hill, then run south-east in shallow valleys or in the bottom of sloping troughs to their junction south of the Knee Hills. From this point it flows south-east for ten miles, the valley being open and shallow, wide flats occurring in many places on each side of the stream. The creek then turns to the east, and after a course of twenty miles, flows into the Red Deer eleven miles above the mouth of the Rosebud, its valley being of a very similar character to that of the latter. At the bend to the east, there is a considerable grove of poplar, and the south side of the valley is also covered with bushes of serviceberry, raspberry and gooseberry. Spruce also appears in the valley about nine miles above its mouth, where it is narrow and 200

Timber.

feet deep. The sides of the valley are very much broken by lateral coulees, which run in from the high lands on either side.

Three Hills Creek rises in a small lake six miles east of Wavy Lake ^{Three Hills Creek.} which latter is drained northward into the Red Deer, and flows south-south-eastward for fifty miles, being joined by Devil's Pine Creek, a stream of similar size to itself, five miles above its confluence with the Red Deer three miles north of the mouth of Knee Hills Creek. After issuing from the lake, it flows for five miles through partly wooded country, then traverses for the next five miles a wide clay flat, the wood receding to the hills on either side. The valley then becomes narrow for six miles, the country on both sides being slightly rolling and covered with good grass. The stream emerging from this narrow valley enters a wide flat, or rather the bottom of a sloping trough, from three to six miles wide. Fourteen miles further down, the valley again narrows in, and from there to the point where it opens into that of the Red Deer, becomes gradually deeper with more abrupt banks. The creek throughout its whole course is fringed more or less with willows, poplar appearing fifteen miles and spruce nine miles above its mouth.

Devil's Pine Creek issues from Devil's Pine Lake, and flows south-south-east for thirty-eight miles to join Three Hills Creek. ^{Devil's Pine Creek.} For five miles from the lake it runs between high ridges covered with poplars; then its valley, though shallow, becomes well defined, and from a quarter to half a mile wide, with sloping grassy banks. The bed of the creek is muddy, till about twelve miles above its mouth where it becomes stony. The water when it issues from the lake is beautifully clear, but it soon becomes of a yellowish green colour from suspended clayey matter. For the last six miles, the valley is steep, and the banks scarped. Here and there a few willows are seen, but little or no poplar till within six miles of Three Hills Creek. The country on both sides of the stream, in the lower part of its course, is slightly undulating prairie, covered with a fine growth of short buffalo-grass.

Looking from the mouth of Knee Hills Creek, the country towards the north and west, is seen to be made up of four large valleys, separated ^{Confluent valleys.} by three salient ridges. The valleys are those of Knee Hills, Three Hills and Devil's Pine creeks and of the Red Deer River, the last, of course, cut down the deepest, but all well defined. The ridges which separate these valleys are open and covered with a thick growth of a grass very similar to the bunch-grass of the foot-hills. They rise from three to four hundred feet above the level of the bottom of the adjoining valleys. The first ridge culminates in the Knee Hills with an elevation of about 3,150 feet, the second, in the Three Hills with about the same elevation, and the third in the Surcee Butte and the

ridge which runs north from it, the Butte itself having an elevation of 3,000 feet.

Country north
of the above
streams.

Quill Lakes.

North of the sources of Three Hills Creek, and north and east of Devil's Pine Lake, there is a small tract from which there is either no drainage or the water is drained off northward into the Red Deer. In it some wide stretches of flat grassy land are met with, but the country is mostly composed of wooded ridges separated by partly wooded valleys or by rolling, partly wooded hills, among which lie a great number of small lakes. In most of these the water is fresh, but the Quill Lakes, which are the largest bodies of water in the district, are very saline, though a number of small lakes which surround them, lying at a slightly higher elevation, are quite fresh. In the summer and early autumn, these lakes abound with ducks, and in the streams further to the south there are still a considerable number of beaver.

Rosebud, Knee Hills and Three Hills creeks are about the same size at their mouths, being about twenty-five feet wide and eighteen inches deep at low water.

RED DEER RIVER.

Source.

Upper course
of Red Deer
River.

The Red Deer River rises in one of the interior ranges of the Rocky Mountains, in lat. $51^{\circ} 30'$, long $116^{\circ} W.$, close to one of the branches of Pipestone Creek, which flows westward into Bow River. It leaves the mountains in lat $51^{\circ} 43'$, long $115^{\circ} 23' W.$, and flows easterly through the disturbed region of the foot-hills, reaching the crossing of the Stoney pack-trail a little east of long. $115^{\circ} W.$, where our examination of it began. It is here a stream of clear blue water two hundred feet wide and two feet deep, flowing over a bed of large quartzite pebbles and boulders. Just below the ford it turns sharply to the north, following the west side of a high sandstone ridge, and is bordered on the west by a strip of bench land, half a mile wide, partly covered with fallen timber. After flowing northward for two miles, it turns again abruptly to the east, having been joined at the angle by William's Creek, a small clear stream fifteen feet wide and six inches deep, coming from the north-west in a little open valley between high ranges of hills. For the next two miles the valley is bounded on either side by gravel terraces, which to the north are open and covered with bunch-grass, but to the south are generally strewn over with fallen timber; the banks then begin to close in on the river and to become thickly timbered, the trail leading for a mile on a bench thirty feet above water level, through a forest of small spruce, most of which, however, are fallen. The river now turns to the north-east, and for three miles runs close to the north side of the valley, which is thickly clothed with good black pine and

poplar; to the south the hills recede, leaving a swampy flat a mile wide covered with a dense growth of spruce. The river here leaves the foot-hills, though to the south it soon comes to be again bounded by low hills on which spruce is growing to an average diameter of eighteen inches. On the north-west side it is bordered by a gravel flat, which continues to widen towards the north, till, where the stream takes a sharp bend towards the east, it opens into a wide rectangular plain bounded on the south and east by the Red Deer, on the north by Bearberry Creek, and on the west by the outer range of the foot-hills. This plain, called by the Indians Bearberry Prairie, contains about fourteen thousand acres of level alluvial land covered with a luxuriant growth of bunch-grass, and would furnish well-sheltered pasture for a large herd of cattle or horses. Opposite the south-east corner of this prairie, Fallen Timber Creek joins the Red Deer River, and for several miles west of its mouth, a plain, similar to the above but covered with scrub-birch and willow, extends on the south side of the latter stream. At the north-east corner of Bearberry Prairie, three and a half miles below the mouth of Fallen Timber Creek, Bearberry Creek joins the main river from the west. It is a small stream fifteen feet wide and eighteen inches deep, rising in the hills to the west, but for lack of time it was not followed up to its source. Below the mouth of Bearberry Creek, the Red Deer flows N. 25° E. for eight miles to the mouth of James' River, or the North Fork. The west side of the valley is occupied by shingle terraces, through which several streams, that drain the relatively high ground to the left, have cut rather deep channels. On the east of the valley a ridge rises two hundred feet above the level of the stream, its western slope being thickly overgrown with small spruce, and its top covered with marshes and spruce and poplar thickets interspersed with a few open grassy patches and small stretches of burnt timber. This ridge falls away at the end of this stretch and gives place to a broad swamp which extends for nine miles to the base of a hill called Ba-how-oo-dan by the Stoney Indians.

Bearberry
Prairie.

Bearberry
Creek.

James' River flows from two small lakes in a gap in the outer range of the mountains, four miles north of the Red Deer Gap, east-north-easterly and then east-south-easterly to its mouth, being, at the point where our trail crossed it, a stream fifty feet wide and two feet deep, running in a beautiful valley fifty feet deep and from a quarter to half a mile wide. The quartzite shingle forming the bottom of the valley is covered with alluvial deposit to the thickness of three feet. On the south there is a fine grove of balsam poplar.

From the mouth of James' River, the Red Deer flows N. 45° E., for twelve miles, to the crossing of the Rocky Mountain House trail, just

above the mouth of Ka-ka-koo Sipi or Raven River. The west bank is rather high, and the country stretching back from the river valley is covered with groves of small poplar interspersed with hay marshes, some spruce and pine being occasionally seen in the small valleys in which little brooks run down to the main river.

Ka-ka-koo
River.

The Ka-ka-koo River rises in the foot-hills between James and Clearwater rivers, and flows east-north-easterly, parallel to and a little south of the latter stream, turning east and then south-east to its mouth, where it is twenty-five feet wide and two feet deep, the lower part of its course being in a wide, open valley covered with excellent grass, and bounded on either side by wooded hills clothed with small spruce and poplar, while some few groves of pine and larch were also seen. The sides of this valley are occupied by two or three benches composed of sandy clay mixed with some quartzite pebbles, the surface being an excellent loam. Wide marshy tracts extend on both sides of the valley, and the hill to the east is called by the Crees Muskeg-wati, or "the Hill by the Swamp." This valley, doubtless, was formerly followed by the Clearwater, and its waters then ran southward to join those of the Red Deer, along a course roughly parallel with that of James and Bearberry creeks.

Red Deer River

From the mouth of Ka-ka-koo River, I descended the Red Deer in a canvas canoe to the mouth of Rosebud Creek, the lower portion of this distance in the summer of 1884, and the upper portion in the summer of 1885. To the mouth of the Little Red Deer the river is winding and very swift, and is bordered alternately by scarped sandstone banks and wide gravel flats, in some cases open and grassed, in others thickly timbered with large spruce. The fall in this distance is about two hundred feet, or fifteen feet to the mile. On the east side of the mouth of the Little Red Deer there is a beautiful prairie slope, on which a little farming was done several years ago, and which has now, I believe, become the nucleus of a thriving settlement. From the mouth of this stream, the Red Deer flows east for a mile and a half, till it is joined from the north by the Ni-pa-gwa-si-mow Sipi, or Medicine River, and the worst rapid that we encountered is in this part of its course. Below the mouth of Medicine River it becomes much deeper and has a more even current, with few rapids. It runs east for four miles, and then north-north-east for fifteen miles, until the village of Red Deer is reached. The sides of the valley are from two to three hundred feet high, scarped in places, but in places declining in a beautiful grassy slope to the water's edge. In this part, too, some islands occur covered with small poplar; and spruce as much as sixteen inches in diameter is growing under the high east bank.

Bad rapid.

At Red Deer, the Calgary-Edmonton trail crosses the river, which is here 475 feet wide. The village is situated on a beautiful alluvial plain on the east bank, behind which the east side of the valley rises in a gentle, partly wooded slope, for one hundred feet, to the level of the surrounding country. This consists of prairies covered with excellent grass, separated by groves of aspen, with a few clumps of spruce in the shallow depressions. The whole is underlain by a rich black loam, and is drained by several small creeks flowing northward. A large number of farms have been established both in the valley and on the upland, and the cultivation of wheat, oats and roots has been carried on with marked success. The west bank of the valley is here steep and scarped, with spruce in the ravines and on some of the slopes. The escarpment is sharply cut by the narrow valley of Swan Creek, which flows in from the west, draining Wapisioo Sakahigan, or Swan Lake, which lies three miles back, occupying an area of about eight square miles and surrounded by a thick growth of poplar and willow. A mile and a half to the north-west of this lake is another three square miles in extent, called Kinapik Sakahigan or Snake Lake.

Red Deer
village.Swan Creek
and Lake.

Snake Lake.

From Red Deer Village to the mouth of Blind Man River, a distance, by water, of eight and a half miles, the river is very crooked, with banks one hundred and fifty feet high, abrupt and scarped on the outer sides of the bends, but on the opposite sides receding from the edge of the stream and leaving room for fine alluvial flats partly wooded with an irregular growth of poplar and willow. A small brook flowing into the river in this part of its course, drives the saw-mill which supplies lumber to the district.

At the mouth of the Blind Man, the Red Deer turns abruptly towards the south-east, and flows in that general direction for fourteen miles, cutting through the high ridge to the east of Red Deer in what is locally known as the "Cañon," in which the banks are high and steep, though not always scarped. Below the "Cañon" the valley becomes a little more open, grassy slopes extending to the water's edge on the north side, but the south side continues thickly wooded. From the end of this stretch, where a brook comes in from the south, the river flows to the east for six miles, between banks rather low and sloping; a small stream ten feet wide and six inches deep, flowing from the north, is here received. Just as the river turns again to the north-east, a thick coal seam is seen cropping out at the water's edge—the same seam that was noticed by Dr. Hector in the summer of 1858 as being on fire for some distance along the banks. When seen in 1884, though it did not appear to be burning, yet the sides of the valley in many places were covered with red and

Canyon.

Coal seam.

yellow cinders, evidences of the combustion which had been going on at no distant date.

Blackfoot trail. From the first coal out-crop the river flows north-easterly, and then easterly for fourteen miles, to the mouth of Tail Creek, where there is a good ford at the crossing of the old Indian trail from Blackfoot Crossing to Edmonton. The banks in this distance are about two hundred feet high, and are for the most part sloping and covered with land slides which support a fair growth of spruce and poplar. From Red Deer, the river as a general rule, is swift, with numerous short rapids, and an average fall of five feet six inches to the mile.

Tail Creek. Tail Creek, which is the outlet of Buffalo Lake, is a swift stream twenty feet wide and two feet deep, flowing southward in a valley two hundred and fifty feet deep and a mile wide. The bottom of this valley, except a small area near its mouth, is of hard clay, and its sides, though bare in places, are generally clothed with poplar, interspersed with a little spruce.

Alluvial meadows. On entering this valley from the west, the Red Deer immediately adopts it and turns sharply in a direction ten degrees east of south, keeping essentially the same course for twenty-four miles. The valley is from two to three hundred feet deep, and for the greater part of the above distance the river winds from side to side, leaving broad grassy alluvial meadows extending from the foot of the slopes which are for the most part grassed, though spruce and poplar grow in the more protected recesses. Opposite these alluvial meadows, high scarped banks rise abruptly from the water's edge, and seams of coal are often quite easily seen as black lines in the midst of strata of light-coloured clay and sandstone. At the end of this course the river turns S. 25° W. for ten miles and the valley becomes wider and much more broken, the

Bad land banks beautiful grassy meadows giving way to beds of white clay sometimes covered with a scant growth of verdure, and the sloping banks are now bare except where an occasional sage bush (*Artemisia cana*) or cactus (*Opuntia Missouriensis*) has been able to secure a hold for its roots. Immense masses of clay and sandstone have been detached from the face of the up-land, either by sliding or by erosion, and stand out in the valley as hills a hundred feet or more in height. When a shower of rain falls, it washes away any seeds that may have been dropped on these "bad-land" buttes, and at other times they are too dry to nourish any but desert plants. In the narrow ravines, however, which run into the valley from either side, some spruce and poplar is growing.

Deep straight valley.

Changing its direction at the end of this stretch, the river runs S. 20° E., for twenty-three miles to the mouth of Three Hills Creek. It is three to four hundred feet wide and two to eight feet deep, with a current of two and a half miles an hour; the channel, however,

is blocked by numerous sand and gravel bars that render it very difficult to navigate, even in a small canvas canoe. The valley is moderately straight, a mile wide, and has almost perpendicular sides four hundred feet high, the general monotony of the view being broken only by groves of timber along the edge of the stream and on sheltered northern exposures.

At the mouth of Three Hills Creek the river turns more to the east; four miles lower it receives Knee Hills Creek, and twelve miles further down reaches the mouth of Rosebud Creek, where Mr. McConnell began his examination of the river in 1883. The valley retains very much the same character as before, grey clays and sandstones forming its steep sides and the "bad-land" buttes which are scattered through it, yet some good grassy flats are occasionally met with. Spruce is still seen on northern exposures and in lateral ravines, while cottonwood and willow form groves by the edge of the water. From the mouth of Tail Creek to the mouth of Rosebud Creek the river has an average fall of three feet to the mile, not taking into account its minor flexures, a current of two and a quarter miles an hour and a mean depth of water of three feet, but the channel is so much blocked by constantly shifting sand bars, that it cannot be considered in any sense navigable. However, as a means of conveying timber and lumber eastward from the wooded country along the base of the mountains, it will be of enormous value to the prairie districts on both sides of the lower part of its course.

Average fall,
&c., of stream.

COUNTRY LYING EAST OF THE RED DEER RIVER AND SOUTH OF LAT. 52°.

In this district we have a wide and, with the exception of a small area near the Hand Hills, treeless stretch of prairie, slightly undulating towards the west but much more rolling in its easterly part, and with a mean elevation of 2400 feet. In its western portion the Hand Hills rise to a height of 3550 feet, being 1350 feet above the river to the southwest and 1150 feet above the surface of the plains to the east.

These hills consist of an elevated table land, the top of which, however, is not flat, but composed of five ridges which radiate from a centre lying to the south-east, showing a rough resemblance to the outstretched fingers of a hand, whence their name. To the north-west, west and south-west this plateau rises abruptly from the sloping plain at its base in bold escarpments five hundred feet high, and thickly wooded in some of the sheltered recesses; but to the east and south-east it slopes gradually to Egg and Little Fish lakes, which are picturesque sheets of clear water lying in the bottom of sloping valleys, the former at an elevation of 2970 and the latter of 2890 feet above sea level. A

Treeless plain.

Hand Hills.

Egg and Little
Fish Lakes.

small stream issues from the west end of Little Fish Lake and flows through a deep, narrow valley, bounded by sandstone cliffs, to join the Red Deer a little way below the mouth of Rosebud Creek.

High ridge.

East of Egg Lake a ridge runs north and south, rising gradually from the lake, level on its top, and breaking abruptly into rolling hills on its eastern slope. Further to the south, where it runs round to the south-east of Little Fish Lake, it breaks into a mass of rolling hills, separated by numerous small freshwater pools, which in summer harbour great numbers of waterfowl. East of this ridge the country slopes gradually to the steep, though in most cases grassy hill-sides bound the wide flat valley of Bull Pound Creek to the west.

Prof. Macoun's opinion of the Hand Hills.

On the economic value of this country for farming purposes, we shall quote Prof. Macoun, who, of all those who have visited this district, is the best qualified to judge of its capabilities. "The Hand Hills district on the Red Deer River south-west from Battleford, in former years was noted for its rich pastures and for the enormous herds of buffalo wintering in its neighbourhood." "While exploring the hills in 1879, I was much impressed with the value of this region as a fine country for stock of all kinds. It may be described as a land of brooks, small lakes and ponds, grassy marshes, and rich bottoms lying between rolling or sharp, rounded hills, which are covered with nutritive grass in summer, and in winter with the same grass, but now converted into excellent hay. Standing on a hill-top and looking over a wide area of grass-covered hills and valleys which stretched out to the horizon on every hand, and which could be extended almost indefinitely in any direction, is it too much to say that here was room for millions of cattle to roam at will and get fat on the very richest grass? No man looking over such a country could doubt its value, for were the grass of the hills to become too dry, the succulent pasture along the lake or pond was close at hand, and if that of the salt marsh was preferred, it was there also."*

Arid Plain.

Between these hills and the Red Deer River there is a sloping, arid plain covered with hard white clay washed down from the face of the escarpment, and bearing very little vegetation except sage-bush and cactus. The rainfall collects in shallow pools on the impervious soil, or is carried off in the deep gullies which lead down to the river. North of this area the country is very hilly, with a soil quite below the average. In the valleys are numbers of shallow lakes, in most of which the water is white from suspended clayey matter washed from their banks. They are fed by a few small, often sluggish, streams,

*Manitoba and the Great North-West, by John Macoun, M.A., F.L.S. Guelph, 1882. pp. 258-9.

but none have any outlet. Sullivan Lake, the largest of these, has an area of about sixty-five square miles. Its immediate banks are low, white and bare, but half a mile back from the water's edge the land rises rapidly, sometimes in a steep escarpment, while the country beyond is covered with a thick grassy sod, furnishing excellent pasture.

East of the Hand Hills the land is imperfectly drained by a number of small streams flowing either southward into Red Deer River or eastward and northward into Battle River. Of these the first met with is Bull Pound Creek, which rises on the northern face of the hills, flows at first for fifteen miles in an easterly direction and then turns due south to its confluence with Red Deer River. In most of the upper part of its course it is confined in a very winding channel in the middle of an extensive mud flat three to five miles wide, bounded on either side by high grassy slopes. On this flat, which is generally wet and often impassable, the place of the grasses is largely taken by some of the species of *Equisetum*, and geese (*Anser Canadensis*) and wavys (*Anser hyperboreus*) congregate here in enormous numbers on their southward migration in the autumn. Three miles south of the eighth base line, the sides of this flat close in and form a narrow definite valley, which the creek follows for the rest of its course. The valley, whose depth averages about sixty feet, is open and grassy for the upper half of its length, but in the lower half willow is growing along the edge of the stream.

East of Bull Pound Creek, between it and Berry Creek, the country is generally undulating prairie, becoming more rolling in the northern portions, with a clay loam soil supporting short grass of excellent quality, and plenty of water is present in small pools. The soil, however, is not deep, and is underlain by stiff clay of the upper portion of the Pierre division, or derived immediately from the disintegration of these beds. A few clay flats are also met with, thickly covered with boulders.

Berry Creek is a small stream eight feet wide and eight inches deep, rising in several ponds east of Sullivan Lake, which at one time it probably also drained. At first it flows S. 20° E. for forty miles, receiving from the west several little tributaries in most of which there is running water only in wet seasons. In the upper twenty-seven miles of this distance it flows through wide grassy flats, though in one place in township 33, rolling hills, approaching it from either side, confine it to an ill-defined stony valley. For the next thirteen miles it winds along the bottom of a valley fifty feet deep and a quarter of a mile wide, with sloping sides of hard clay. The creek then turns and flows S. 25° W., beyond the limits of the accompanying map, in a

wider and more sloping depression. The whole distance from its source in a straight line to its junction with Red Deer River is about eighty miles.

Beyond Berry Creek is a broad expanse of undulating or rolling prairie, underlain by good sandy soil, and usually covered with an even growth of short grass which a few years ago nourished great herds of buffalo; as late as the summer of 1884 a band of about twenty-five was seen by the writer close to the valley of Berry Creek.

Sandy ridges.

On the more level tracts, low sandy ridges are occasionally seen, often being the only elevations which break the endless monotony of the landscape. The sole drainage channel is that of Sounding Creek, which in dry seasons is, for part of its course, merely a series of disconnected saline pools. The most of the rainfall of the area collects into shallow lakes, some of which are fresh, while others are saline, with wide borders of soft white mud. In crossing the country, columns very like smoke, and as much as a hundred feet in height, are seen curling up into the air; but on nearer approach they are found to be white dust from the edge or dry beds of these "alkaline" lakes, raised by little whirlwinds which have been caused by the expansion of the atmosphere over the bare white clay heated by the glare of an unclouded sun.

White dust.

Good pasture.

Much of this country, however, is well fitted either for cultivation or for pasture, the soil being rich and the rainfall sufficient for the growth of cereals. Prof. Macoun writes of it:—"The Great Plain, as far as known, is not arid, but produces good grass, has generally abundance of water, and usually a good soil," and "as this same region was the winter home of the buffalo, so in the near future it will be the winter home of immense herds of cattle, which can exist, as they did, by going on to the wind-swept hill tops for nutritious food, when the poorer grass of the valleys lies covered with a mantle of snow."*

Sounding Creek.

Sounding Creek rises in the north-western portion of this area, though it is difficult to determine its exact source, as many flat lakes doubtless overflow into it in high water, which are quite cut off at ordinary times. At the crossing of the Lord Lorne trail, however, it has a well-defined channel, and from this point we followed it down in the early summer of 1886. At this place (on May 29th) it was merely a succession of isolated pond holes, but further to the east its valley deepens and becomes more defined, at the distance of six miles the sides being seventy feet high, with a clear cool stream of water flowing at their base. The valley, however, soon again becomes shallow and for the next twenty miles is wide with sloping sides and well defined flats through which the creek winds, while on

* Manitoba and the Great North-West, by John Macoun, pp. 102 and 104.

either hand rough hills rise to a height of one hundred and fifty feet. In a few places, small willows, gooseberry, silver-berry and currant bushes fringe the edge of the brook. Below this the stream continues to flow eastward for eleven miles, first in a narrow valley with steep clay and sandstone sides covered with sage and cactus; afterwards the banks are lower, becoming more sloping and grassy, though high ridges are seen in the distance in every direction. The creek then turns sharply to the north in a wide, flat valley, and, after a course of forty-four miles, empties, or rather leads, into Sounding Lake, for in this part of its course there was little running water, the stream having dwindled to a succession of disconnected pools occupying its channel. On both sides the land rises to a height of three hundred feet in a succession of ridges, covered with short grass, and with many boulders scattered over their summits. In the valley of a small tributary coming from the west, in lat. 52°, there is a small quantity of poplar of fair size, but otherwise the district is treeless.

DISTRICT BETWEEN LAT. 52° AND BATTLE RIVER.

This exceedingly irregular area, in its southern portion, is essentially a continuation northward of the foregoing, but clumps of willow and poplar gradually make their appearance on the northern slopes, and a little further north the surface becomes largely covered with these trees, patches of prairie constantly separating the wooded areas. Water, too, is everywhere abundant, either in lakes or small streams. In the western portion, near Buffalo Lake, fifty little lakelets were counted from the top of a low eminence.

Northern limit
of plain.

This district is divided into two fairly distinct portions by a line running south from the Elbow of Battle River, the two parts differing very considerably in their physical characters.

The western portion is more or less wooded throughout, and bears as well, a strong growth of rich nutritive grasses mixed with vetch and astragalus, forming excellent pasture, and when cut making the best of hay for feed during the winter. The soil, too, is a rich sandy loam, and well suited for agriculture. Besides, even if wood were not plentiful, the land is underlain by large seams of coal, which will furnish abundance of fuel not only to those who settle in the immediate vicinity, but to others at a distance who are not so favourably situated.

Of the natural reservoirs into which the superfluous rainfall of this area is collected before being discharged into the main rivers, Buffalo Lake is the largest. According to Mr. Sullivan, Capt. Palliser's secretary, it received its present name, which is a translation of the Cree

name "Moostoos Sakhähigan," from its resemblance in contour to the outstretched hide of the buffalo, Tail Creek, by which it discharges into the Red Deer River, representing the caudal appendage. It is a beautiful body of fresh water, sixty-four square miles in extent, surrounded on all sides by high, wooded hills, that, however, in some places, recede to a considerable distance from the shore, leaving rich tracts of bottom land. On these fertile meadows, especially along the western side of the lake, the Metis had for many years a flourishing settlement, and, although they have lately almost abandoned it for other places nearer the main trails, still it is a noteworthy fact, that wherever we find any of these old settlements we are almost certain to find the richest land in the neighbourhood.

Spotted Creek.

The principal feeder of this lake is Spotted Creek, which flows into it from the west after passing through Spotted Lake in the lower part of its course. It is a clear cool stream fifty feet wide and eighteen inches deep, with an easy current. Rising in the ridge to the east of Wolf Creek, it flows eastward through a wide, mostly open, valley bordered by high, wooded hills. The bottom of the valley which in places is two miles from side to side, is generally marshy in its upper part, and a number of brooks here join the main stream from the north, while in its lower portion it is a rich dry sandy loam, which would certainly yield the farmer an ample harvest.

Meeting Creek.

Meeting Creek is the only other stream in this district that merits special notice here. It has its source in some small lakes, and after a south-easterly course of thirty-two miles flows into Battle River, receiving Big Knife Creek as a tributary from the south six miles above its mouth. At the crossing of the Swift Current and Edmonton trail it is a swift stream twenty feet wide and two feet deep. In the upper part of its course it flows in a sloping grassy valley the southern side of which is varied with a scattered growth of poplar, but in its lower part the sides, which are one hundred and fifty feet high, become very steep and bare, bad-land buttes similar to those on the banks of the Red Deer, standing out in the middle of the valley. On either side the country is undulating or slightly rolling, with a great deal of poplar or willow scrub, interspersed with many small shallow lakes.

Sounding Lake.

East of the line drawn southward from the Elbow of Battle River, the country is much rougher than to the west, and sandy barren tracts are scattered about among its fertile portions. The only body of water of any size in this district is Sounding Lake, which receives Sounding Creek from the south, and is drained eastward by Eye Hill Creek into Manito Lake. Its general form is that of a horseshoe, with sides five miles long and from a mile to a mile and a half wide. The shore is of rounded sand, on which is piled in places a wall of large

gneissoid boulders. The water is slightly milky when free from weeds, and not unpleasant to the taste, but is usually green from the presence of great numbers of minute algæ, and in a high wind rolls up on the shore in opaque, pea-green waves, which make a loud roaring on the stony beach. It is on this account that the Indians have given it its present name, the fact being remarkable, as most of the lakes on the plains have clay or sand beaches, on which the water breaks with very little noise.

The lake lies in the centre of an irregular sandy flat, which is con- Wide flat.
stricted in the middle by rolling hills approaching each other from the north and south, but is spread out at either end to a considerable distance beyond the present borders of the lake. To the north, an irregular mass of rolling hills stretches for ten miles, separated by chains of lakelets, the most easterly of which are saline, while the rest are fresh. The southern slopes of the hills are grassy, the northern slopes and many of the intervening depressions are covered Wooded hills.
with aspen and balsam poplar, the whole forming as beautiful a landscape of hill and valley, meadow and woodland, as can be seen in the North-west.

South of the lake the view is cut off by a ridge of high grassy hills High hills.
from two to four miles distant, through a gap in which Sounding Creek finds its way north in a wide deep valley. This ridge extends to the west as a high, rolling plateau, dotted with numerous fresh water lakes, around which a few willows are occasionally growing. The soil is a light sandy loam covered with a fine growth of short grass. Towards the west, the plateau is intersected by deep narrow gaps and, finally, by a stretch several miles wide, separating the "Nose" from the main The "Nose."
ridge. This stretch, with the country several miles to the south, is covered with rolling grassy hills, between which lie fresh-water ponds, often fringed with poplar and willow.

South-west of the "Nose," which is a bare, rounded hill rising to Ribstone Creek
a height of five hundred and thirty-five feet above the plain, Ribstone or Nose Creek, takes its rise, and flows northward in a narrow valley, which soon begins to be wooded with willow, poplar and maple (*Negundo aceroides*), a few moribund specimens of this latter tree having also been seen on the north side of Sounding Lake. Then, turning eastward, and cutting through a north and south ridge, it enters a broad, grassy flat, in which its edge is skirted by low woods, among which birch and maple are conspicuous. Some of the latter here measure thirty-three inches in circumference two feet from the ground, but the trees are low and branching, and not at all suited for timber. Among the shells which were found in the creek, *Anodonta Footiana* was very plentiful.

For eighteen miles north-eastward the valley is for the most part almost treeless and bounded to the north by broken, arid hills, while the high ground to the south is of a much more attractive character, the steep sides being often clothed with a close growth of poplar. At the end of this north-easterly course, where the stream turns to flow north, there is an extensive clay flat devoid of grass, but sparsely covered with small sage-bush and stunted cactus, among which some northern jack-rabbits, or prairie hares (*Lepus campestris*), were seen disporting themselves. It is not improbable that this species of hare ranges a little further north on the plains to the east, but this is its northern limit, as far as my observation goes.

Jack-rabbits.

Lower course of creek.

For seven miles north of the bend, the creek winds through a low marshy belt at the bottom of a wide, open, sloping valley. The wooded country then begins, and down to the mouth of the creek, though grassy stretches of considerable extent occasionally occur, timber is always within easy reach. In this distance, the bottom of the valley is often swampy, but sometimes it is hard and dry. The land on either side is sandy in many places, and especially towards the west becomes a rich sandy loam. The surface is generally rolling the hills being often clothed with medium-sized poplar, and in the depressions are many small lakes, mostly containing good water, around which the pasture is of the finest quality. Although this area on the whole is not as fertile as that to the north and west of it, yet there is here much desirable land, which, though rather sandy and not so rich as more clayey soil, still is warmer and will bring crops to maturity earlier in the year, there being thus far less danger from early frosts.

Light soil.

BATTLE RIVER.

Battle River.

Battle River is a stream from fifty to two hundred feet wide, flowing in a very tortuous channel, for the most part in the bottom of a deep and winding valley, though occasionally the brim of the channel is but little below the level of the surrounding plain. It issues from a narrow lake in lat. $52^{\circ} 57'$, long. $114^{\circ} 9' W.$, and flows in a general eastward direction across the middle of the area embraced by the accompanying map, falling into the Saskatchewan a mile and a half below Battleford, in lat. $52^{\circ} 43'$, long. $108^{\circ} 10' W.$ From the lake, for forty miles, it flows south-east in the bottom of a straight, well-defined valley, averaging half a mile in width and a hundred feet in depth, the sides of which for the first twelve miles or as far as the mouth of Pigeon Creek, are constantly wet from a number of small springs, while the flat on either side of the river is boggy and is either covered with tufts of long grass.

Pigeon Creek.

or with a thick growth of spruce and tamarac. Pigeon Creek, the outlet of Pigeon Lake, is a swift clear stream thirty feet wide and one foot deep, flowing over a bed of quartzite pebbles in a narrow but rather deep valley. Below Pigeon Creek the main valley is much drier, with pleasing alluvial grassy intervals and sloping sides, mostly grassy to the north and about half wooded with small poplar to the south. In township 44, range 27, Beaver Creek, a small stream in a channel Beaver Creek. ten feet wide, flows in from the west. The country on either side of the river is, on the whole, rather poor and often stony, with many marshy tracts, though the drier parts are dotted with charming groves of aspen and willow. At the end of this south-easterly course, the Calgary-Edmonton trail crosses the stream, which is here fifty feet wide and two feet deep with an even current of two miles an hour. From the bridge it flows N. 30° E. for eight miles between low banks skirted with overhanging willows, while, a short distance back, conspicuous hills rise to a height of from a hundred to two hundred feet, Conspicuous hills. though in one place the ridge to the east approaches close to the edge of the river. At the lower end of the above course the banks decline slightly, and the stream turning eastward for eleven miles flows here over a bed of quartzite pebbles and becomes much more rapid. The banks are grassy or covered with small willows, and the country on either side is beautiful grassy meadow-land interspersed with groves of poplar and underlain by a rich soil of friable clay-loam. The river then, Fertile meadow after traversing a low willow swamp, flows into Battle River Lake, the muddy bottom of the stream here nourishing great numbers of *Unio luteolus*, *Anodonta Footiana*, and *Margaritana complanata*, the latter, judging from the number of freshly broken shells, having evidently furnished many a meal to the mink or muskrat.

Battle River Lake is a shallow expansion of the river, about four Battle River Lake. square miles in area, filled with a tangled mass of weeds that come almost to the surface of the water. It serves as an excellent settling basin, for while the water flowing into it is muddy, that flowing out is clear, though dark-colored and with a very swampy taste. Its eastern shore is high and covered with a mass of large gneissoid boulders, beyond which is a gentle slope rising to the level of the surrounding partly wooded country. The western shore is low and marshy, and towards the south a prominent hill rises to a considerable height above the surface of the lake. Battle River flows out at the north-west angle of the lake, keeping a general northerly direction for six miles, the banks being at first marshy and then dry and sloping, fringed with balsam poplar and willow. After an easterly course of four miles in a channel twenty to thirty feet deep, the river again turns northward and runs through a narrow and constantly deepening valley till it is

joined by Pipestone Creek from the west. From the lake to here the bed of the stream has been stony, or sometimes covered with large gneissoid boulders, which cause a succession of difficult rapids. The valley is wooded with poplar as well as spruce in the lower part, and the surrounding country is rich rolling land, on which there is now a flourishing settlement of half-breeds.

Pipestone
Creek.

Pipestone Creek rises in the hilly and swampy country east of Pigeon Lake, and flows a little south of east to join Battle River at its easterly bend, receiving Bigstone Creek, which drains Bear Lake from the south-west, ten miles above its mouth, and Long Lake Creek from the north-west, six miles lower down. It flows in a wide valley one hundred and fifty deep at its mouth, the valley of Battle River appearing like a narrow lateral valley joining it from the south. At the mouth of Long Lake Creek the valley divides into two, the larger and main portion being occupied by Long Lake and the creek which drains it, while the united streams of the Pipestone and Bigstone wind along the bottom of the more southern and smaller branch of the valley.

Dried Meat
Lake.

At the mouth of Pipestone Creek, Battle River adopts its valley and maintains a general south-westerly direction for eighty miles, with sides throughout the distance from one to three hundred feet high, the lighter slopes being grassy and the steeper covered with poplar, spruce and birch. The river, for most of the distance, winds slowly in a very tortuous channel through alluvial flats covered with a scattered growth of willow, though at Dried Meat Lake it spreads out and fills the valley from side to side for a distance of eleven miles.

Half-breed
settlement.

At Salvais' Crossing, four miles above the head of this lake, there is a flourishing settlement of French half-breeds, consisting of about forty families. They are living in substantial log houses, and there is sufficient land under cultivation to raise all the field produce that can be used in the settlement. In July, 1885, wheat, barley, oats, potatoes, turnips and Indian corn were well advanced, and I was informed that for the last seven years there had been no failure of crops; seven years being the length of time that my informant had lived in that part of the country. A considerable number of horses, cattle and sheep were also seen around the houses, and all were in excellent condition.

Maple groves.

Dried Meat Lake gradually narrows again into the river, which then meanders slowly through the bottom of a broad valley, whose sides rise gently for 300 feet from the flats ten feet above the level of the water. On the eastern side of township 43, range 18, the flats are studded with groves of ash-leaved maple (*Negundo aceroides*), many of which are a foot in diameter, and here the Indians have been accustomed to resort in spring to collect the sap and boil it down to a coarse sugar.

Maple is seen in many places further down the valley, but seldom in larger or finer groves than at this point, its extreme western limit.

From the "Maples" to the Elbow, the river retains its winding character in a valley one mile wide at the top and two to three hundred feet deep. It has an average width of a hundred feet and an even current of a mile and a half an hour. The more projecting portions of the sides of the valley are very often composed of bare clay or white sandstone, while the more sloping recesses are filled with gooseberry and serviceberry bushes. Several small streams flow in from the south, draining high ground a few miles back from the river, but the north bank is unbroken by any but short lateral gullies.

At the Elbow, where an old trail crosses from Victoria to the plains to the south, the river turns N. 55° E., keeping this course for nineteen miles in a gradually expanding valley, the sides of which become at the same time more thickly covered with vegetation. The river is still very winding, with stretches of quiet water, separated by short rapids, in which the bottom of the channel is covered with pebbles and boulders. At the eleventh base line, the river turns sharply northward for sixteen miles to the mouth of Iron Creek, a small clear stream six feet wide and seven inches deep. The valley in this distance is wide and open, with sloping grassy banks and a bottom occupied by level well-grassed flats fifteen feet above the water, fringed with a narrow belt of poplar, maple and willow, close to the edge of the very winding stream.

Below the mouth of Iron Creek, the valley maintains very much the same character as far as the mouth of Grizzly Bear Creek, the sides being sandy and more or less sloping, sometimes well grassed or covered with timber, and sometimes almost bare, merely supporting a stunted growth of rose-bush and trailing juniper. The river is from a hundred to a hundred and fifty feet wide, sometimes very winding, and again flowing slowly over a sandy bottom in long, straight courses. In this distance it receives from the west Grattan and Buffalo Creeks, which are each about five feet wide and six inches deep.

At the mouth of Grizzly Bear Creek, the river turns sharply south for four miles, then east five miles, south five miles, and then a little south of east twenty miles to the crossing of the Fort Pitt trail. For this distance the valley is from 250 to 300 feet deep, with steep, grassy or partly wooded sides, and a bottom half a mile wide, intersected by old river channels, between which the flats are sometimes grassy, but usually covered with small poplar and willow.

COUNTRY BETWEEN BATTLE AND NORTH SASKATCHEWAN RIVERS.

"Fertile belt." Lying north of Battle River, and south of the North Saskatchewan, is the western portion of what has been known for a long time as the great "Fertile Belt," which stretches from the edge of the northern forest to the northern limit of the plains to the south. The district now under consideration consists of over 6,000,000 acres of fertile land, partly covered with groves of poplar and willow, but with everywhere, more or less extensive tracts of open country covered with luxuriant grass and herbage, ready to be used as pasture land, to furnish an abundant supply of hay for winter use, or to be broken by the plough.

In the southern portion of this district, which is drained by Battle River and the small streams that flow into it, the extent of prairie is very largely in excess of the woodland. The surface is generally undulating, and the soil is a rich sandy loam. Water is abundant in lakelets and small streams, though nowhere is there wet land that could not be readily drained. Prof. Macoun, in speaking of this country, says, * "This tract is unsurpassed in the North-West for its capacity to grow wheat, as the soil is rich, the surface is almost level, and what slope there is inclines to the south."

Of the brooks which drain the country into Battle River, Iron Creek is the most southerly. It received its name, which is merely a translation of the Cree Pi-wā-pisk-oo Si-pi-sis, from the fact that a large mass of meteoric iron, now in the Museum of Victoria College, Cobourg, used to lie not far from its banks. Wavy Lake, of which it is the outlet, has an area of about 5,000 acres, bounded either by a hard, sandy beach, scattered over in places with pebbles of quartzite and gneiss, or by a low marshy shore. The water is good. From the south-east angle of the lake, the creek flows eastward for twenty-one miles, at first across a wide and, close to the creek, often marshy plain, and then in a valley which gradually increases to sixty feet in depth. It then turns south-eastward for sixteen miles to its mouth, its valley gradually becoming deeper and wider, till five miles above its mouth it is filled with an irregular mass of almost bare sand-hills.

Grattan Creek.

North of Iron Creek, Grattan Creek has its source in a series of long, saline lakes, and after flowing S. 75° E. for fourteen miles through a deep, narrow valley, empties into Battle River. The country between these two creeks is rolling, or sometimes hilly. North-east of Grattan Creek, Buffalo and Grizzly Bear creeks rise in the rolling land a short distance south of the southern bend of Vermilion River, and flow

* Manitoba and the Great North-West, by John Macoun. p. 109.

Soil a rich
loam.
Water
abundant.

Buffalo and
Grizzly Bear
Creeks.

south-eastward into Battle River, being respectively twenty-six and thirty-two miles in length. The valleys in their lower portions become deep and narrow, the south sides being generally thickly wooded while the north side is grassy or scarped.

The most easterly affluent of Battle River which comes within the area now reported on, is Blackfoot Creek, a small stream that rises in a rough and wet part of the country ten miles south of the northerly bend of Vermilion River, and flows S. 20° E. for thirty miles, to join Battle River two miles below the crossing of the fourth principal meridian. For part of its course it winds in a narrow channel through flat, open country, but in township 49 it cuts through a high ridge of hills in a deep wooded or grassy valley, and south of the crossing of the old telegraph trail its valley again becomes defined and then steadily increases in depth to its mouth. West of Blackfoot Creek, the Blackfoot Hills rise from three to four hundred feet above the level of the plain. Their contour is, however, not at all clearly marked out, and they appear more like tracts of high rolling country than as well-defined hills. Their slopes are covered with a luxuriant growth of grass, dotted with a few groves of small poplar. A few boulders are seen in places lying on their surface.

North of the drainage area of Battle River, the greater part of the rainfall is collected by Vermilion River and its branches and poured into the North Saskatchewan, thirteen miles west of the fourth principal meridian. Near the same point, the western end of Grande Coulée opens into the Saskatchewan valley, while its eastern end joins the same valley thirty miles beyond the eastern limit of the map. It is a wide, generally well-defined, and in places terraced, valley, which at one time has carried the waters of the North Saskatchewan by a more southern channel than the one that the river now occupies.

Ascending the Vermilion River from its mouth, the valley is from a quarter to half a mile wide, with sloping, mostly grassy banks, while the surrounding country is prairie underlain by moderately rich sandy loam, and dotted with groves of aspen and willow. The river is about sixty feet wide, with a bed of sand or gravel. Among the shells found on the sand bars were those of *Unio luteolus*, *Anodonta Footiana* and *Margaritana complanata*. For nine miles above where the valley turns to the west, it is exceedingly crooked, about half a mile wide and two hundred feet deep, with steeply sloping, partly wooded sides, broken by deep lateral gulleys. The upland to the south is almost open prairie, while to the north it is half wooded with small aspens, though when we passed, a fire was stripping the country of everything green, both grass and trees. For the next twenty-six miles, or as far west as

- Winding valley the centre of range 8, the valley continues very winding and from one to two hundred feet deep. The bed of the stream is usually a soft mud, though a few stony rapids occur at the bends, and the bottom of the valley is a stiff clay. In many places the sides rise in somewhat irregular, grassy terraces, on which travelling would be very pleasant were it not that they are often cut through by deep, narrow gulleys, which it is often impossible to cross. In ranges 5 and 6, the country back from the river is rolling, but along the brink of the valley there is a level belt covered with a luxuriant growth of grass, which was evidently at one time a favorite camping ground of the Indians, as their old lodge-poles are even yet strewed over it in great numbers. In the middle of range 8 the river flows S. 70° E. for seven miles from the mouth of Birch Creek, in a valley wider but not so deep as further east, and bounded to the north by a high range of hills from which small streams flow down in deep gulleys. Birch Creek is a small stream of clear brownish water, fifteen miles long, and near its mouth flowing in a deep, narrow gulley, but higher up it winds through the prairie in a very tortuous channel. In high water it doubtless drains Birch Lake, but when examined in August, 1886, it rose in a swampy bottom to the east of that lake. At the same time of the year, Birch Lake was a beautiful sheet of clear but slightly saline water, with very irregular outline, long, wooded or partly wooded points stretching into and almost dividing it in several places. Its shores are flat in a few places, but for the most part rise gently to a height of about a hundred feet, the south side being almost entirely open prairie, the other sides being more or less wooded with aspen or balsam poplar, always varied, however, with open glades. The beach is firm and of a coarse yellow sand.
- Chain of Lakes. Above the mouth of Birch Creek, the valley of Vermilion River stretches for twenty-one miles N. 30° W. as far as the "Chain of Lakes," the sides being at first steep, and the southern one clothed with poplar, birch and spruce, but they soon become more sloping and rise in grassy or lightly wooded terraces to the level of the surrounding country. At the outlet of the most easterly of the lakes the river flows among huge Laurentian boulders, and falls several feet in a few hundred yards; for eighteen miles above this, it flows through low-lying marshy lakes, with soft muddy shores; in the autumn, these lakes are teeming with wild fowl. The sides of the valley continue as before to rise in long irregular slopes to the general level, or in some places even into conspicuous hills.
- At the "Chain of Lakes," the definite valley that we have been describing turns more toward the north, while Vermilion River flows into it from the south. This river rises near the old telegraph line,

and flows at first northward in a slight depression on the prairie, but soon it cuts a shallow channel, which continues to deepen slightly, till at a distance of thirty-five miles from its source, the river flows from a marshy flat into the south-western lake of the "Chain." The main valley, however, continues north-westward to the Saskatchewan, and has formerly carried a very much larger stream of water than that which at present flows through it. This original stream, doubtless, occupied part of what is now the valley of the Saskatchewan, but where it entered that valley it is impossible to determine with the information at present at our disposal, though it is highly improbable that it followed its valley a the way from the mountains. Towards the east this ancient stream, instead of turning northward again towards the Saskatchewan, continued south-east through Grizzly Bear Coulee into what is now the valley of Battle River. Old valley.

North-west of the "Chain of Lakes," Egg Lake lies near the head Egg Lake. of a small creek which flows northward into the Saskatchewan. Its water is clear and good. Its shore is well defined by a beach, at least, on the eastern side, of pebbles and small boulders, often, however, fringed with reeds for a considerable distance out into the water. Its northern and larger portion has a rounded outline, but towards the south-east, deep reedy and doubtless shallow bays, indent the shore. On the west side the country is thickly wooded, but towards the east, it is prairie, broken by small lakes and dotted with poplar groves. West of the upper part of Vermilion River, the surface is rolling, and the land is a rich clay-loam, more or less closely wooded with thickets of poplar and willow. Ascending over a low ridge we look down into a beautiful valley, the bottom occupied by Beaver Lake, which is Beaver Lake. fifteen miles long and eight and a half miles wide, and with a rather regularly oval outline. It appears, however, to be very shallow, and the water, though sweet, is generally slightly milky from suspended clayey matter. Pike certainly, and perhaps other fishes, are present in it in very considerable numbers. The shore is low with a beach of coarse quartz sand, often clayey, and sometimes blocked by a row of large boulders. To the north a rich, though treeless, prairie stretches away for several miles, while in every other direction, a wide belt of open or lightly wooded prairie slopes gently to the water, with a soil of fertile black, sandy loam, bearing a luxuriant growth of grass.

Lying west of Beaver Lake and east of the Calgary-Edmonton trail, there is an apparently high and thickly wooded country which goes by the name of Amisk-wachi or Beaver Hills. Of this country Beaver Hills. very little could be learned, even from those who were living in the immediate vicinity, and it has been left as a hunting ground for the

Indians, who yearly kill a large number of moose in the deep recesses of its forests. On entering the "Hills," however, the most striking feature is the absence of the rough, hilly character which their name and reputation would lead one to expect. The country is found to be simply low ridges or sandy knolls, often thickly clothed with large balsam poplar and spruce, separated by valleys drained by numerous small streams. These streams have been everywhere dammed back by beaver, giving rise to extensive meadows, which are either impassable marshes or, since the beaver dams have been broken down, are again drained by the creeks and form beautiful wide alluvial tracts covered with long grass, from which sufficient hay could be cut to supply very large herds of cattle and horses. At present, however, there are no roads through this luxuriant wilderness, though the making them would be a very easy matter, or, at all events, access could be had to the interior in winter over the marshes themselves, which almost everywhere stretch to the verge of this low sandy plateau. The hills, too, are diversified throughout by charming lakes of clear pure water. Cooking Lake, the largest of these, is from seven to nine miles long, two and a half miles wide, and apparently quite deep. Its beach is white sand or a gravel composed of gneiss, quartzite and quartzitic sandstone; it is often skirted with a scanty growth of rushes, and backed by a narrow grass-covered belt which rises slightly into thick woods of poplar or spruce. It is reported to contain pike and suckers, but doubtless whitefish would thrive in its waters if they were introduced. A stream twelve feet wide and a foot deep, flows south-westward from Cooking Lake into Hastings Lake, which is another body of water of considerable size, and which is drained by

Extensive meadows.

Cooking Lake.

Hastings Lake. Swift Current or Hastings Creek eastward into Beaver Lake. There are three other principal creeks which flow from these hills, namely;—

Katchemut's Creek. Katchemut's Creek, ten feet wide and a foot deep. An old Indian pack trail to Edmonton, which at one time was well cut out, runs up the north side of this creek. The surrounding country is generally wooded with small aspen and willow.

Ross Creek. Ross Creek, eighteen feet wide and six inches deep, rises in the northern part of the hills, and, flowing through Dry Grass Lake, empties into the north-eastern part of Beaver Lake.

Deep Creek. Deep Creek, six feet wide and one foot deep, rises in the northern part of the hills, in or south of Island Lake, and flows northward to join the Saskatchewan in the south-west corner of township 56, range 21. There are besides a number of small creeks, which drain the hills in every direction towards the surrounding lower lying country, in all of which the water is clear and good, though in the drier seasons they are often merely a succession of water holes. The hills are much more heavily wooded

in their northern than in their southern half, and besides balsam ^{Trees and shrubs in} poplar (*Populus balsamifera*), aspen (*P. tremuloides*) and spruce (*Picea* ^{Beaver Hills.} *alba*), tamarac (*Larix Americana*) and birch (*Betula papyrifera*) are quite commonly met with. Some *P. tremuloides* were seen, which measured five feet in circumference three feet from the ground. Berries, too, were very abundant, the following being the most common: Service-berry (*Amelanchier alnifolia*), choke-cherry, or stone-berry (*Prunus Virginiana*), haws (*Crataegus coccinea*), eye-berry (*Rubus chamemorus*), moose berry (*Viburnum pauciflorum*), Pembina berry (*Viburnum Lentago*?).

South of the Beaver Hills the country is lightly rolling or level, and very much broken by large and small marshy lakes, with outlines varying considerably with the height of the water. To the west of ^{Marshy country.} this flat country a deep, narrow valley runs nearly north and south, at present connecting the head of a small stream that flows into Pipestone Creek with Black Mud Creek, flowing north into the Saskatchewan. These streams are quite insufficient to account for so large a ^{Old valley.} valley, a valley of which that of Battle River is merely a continuation, and therefore, as in the case of the Vermilion River valley, we are forced to the conclusion that we have here one of the old drainage channels through which the Beaver Hills and surrounding country were drained southward into Battle River before the southern continental elevation diverted the rivers into more northern channels, and especially before the Saskatchewan had carved out the valley in which it now flows.

DISTRICT BETWEEN THE RED DEER AND NORTH SASKATCHEWAN RIVERS AND THE CALGARY-EDMONTON TRAIL.

This district is divided very unequally by a high, wooded ridge, which runs from the banks of Clearwater River, N. 30° E. to the angle of the Saskatchewan, a short distance above Edmonton, and which causes the rain-fall to the north-west of it to flow northward into the Saskatchewan, while to the south-east the country is drained by tributaries of the Red Deer and Battle rivers.

The general character of the country, on the opposite sides of the ^{Character country.} ridge, is similar or different, according as we consider the character of the soil and the contour of the surface, or the vegetation with which it is covered. On both sides the soil is sandy, often mixed with more or less clay, and the surface is flat over considerable areas, but in places broken by high ridges of hills. On the tributaries of Red Deer and Battle rivers there are many wide stretches of prairie or of partly timbered country, and, where the woods are most continuous, the trees

are either poplar or small spruce and pine, furnishing plenty of timber for local use, but not enough to be of much value as an article of export. In the country which is drained northward into the Saskatchewan, however, there are wide marshy tracts along the banks of the streams, while beyond, on the plains and hill-sides, there is usually a thick growth of spruce, balsam and pine, often small, it is true, but much of it is very large and well suited for converting into timber or lumber. The difficulty, of course, would consist in getting the logs to the Saskatchewan. They could, doubtless, be driven on the lower portions of some of the streams in high water, while in other places roads would have to be made directly to the river, which would often necessitate the outlay of considerable capital before any large returns could be depended on.

Thick forest.

Wolf Creek.

Some of the finest trees seen were in or near the valley of Wolf Creek, a stream which rises in the watershed ridge, seven miles north of the eleventh base line, and flows N. 20° W. for thirty-three miles, joining the Saskatchewan sixteen miles below the mouth of Brazeau River, where it has a channel seventy-five feet wide and five feet deep. Near its source it flows in a shallow channel through thick forest of large spruce and balsam fir mingled with poplar, the ground, even in October, being often very swampy. Ten miles down the stream, a small creek joins it from the south-west, draining a wide, hill-

Boggy country.

surrounded valley, the bottom of which appears to be one extensive bog. For four miles below the mouth of this branch creek, the valley is narrow and wooded, and the trail that we followed kept on the side of the hill to the east, the soil here being sand or gravel covered with either small pine or windfall, a little grass generally growing among the scattered logs. Below this point, where the old pack-trail from Buck Lake to Rocky Mountain House turns up into the hills to the west, to the crossing of the twelfth base line, the valley is from two to four hundred yards wide, with pretty little alluvial meadows covered with rich pasture in the bends of the stream, bounded on either side by rough, rolling land, the most of which has formerly been well wooded, but a great many of the finest trees have been destroyed by fire. From the twelfth base line to the Saskatchewan, the creek is as yet unexamined. The water is of a brownish hue, but clear and transparent, flowing over a bed of pebbles or sand, in places scattered over with gneissoid erratics, the banks throughout appearing to be composed of glacial drift, though often the Laramie sandstones and shales must be but a short distance from the surface.

Old trail.

Beavers.

In most of the streams of the West, the beavers have been so much hunted that their number is at least greatly reduced from what it formerly was, but here the number is still large, the stream being

constantly blocked up by their dams, and the large, well-kept houses in the centre of ponds close to the creek, continue to protect many an industrious family that has exacted a heavy tribute from the young poplar and willow of the surrounding woods. East of Wolf Creek, the Buck Lake trail, which was the one we followed, leads over an attractive plain dotted with small pine and poplar, and then up a willow-covered valley bounded by wooded hills. From the edge of this valley to Buck Lake, a distance of seven miles, the trail leads through a thick forest of spruce up to twenty-nine inches in diameter. Large spruce. With the spruce were growing balsam poplar, pine, and a few balsam fir.

Buck Lake, into which several small streams flow from the high ^{Buck Lake.} ridge to the south, is a very pretty sheet of clear blue water, surrounded on all but the south side by wooded ridges, while to the north-east two prominent hills rise sharply above the surrounding country. The beach on projecting points is of rounded quartzite and gneissoid shingle, but at least in the bays which indent its southern shore a wide marsh or moss-covered muskeg skirts the lake; beyond the muskeg stretches a thick forest of spruce. About the middle of the southern border, along a small creek, there is a fine prairie of about fifty acres in extent, covered with a close and rich growth of grass and wild pea-vine. The lake is said to contain large whitefish of particularly fine flavour, and it was from here that fish used to be supplied to the Hudson's Bay Company's post at Rocky Mountain House.

From the north-east corner of the lake, Buck Creek flows northward ^{Buck Creek.} towards the Saskatchewan, into which it empties eight miles above Goose Encampment, having there a channel eighty feet wide and four feet deep.

East of Buck Creek, Strawberry, Weed, Conjuring and White Mud ^{Other small creeks.} creeks flow northward into the Saskatchewan, with channels at their mouths from thirty to fifty feet wide. Most of the country drained by these streams is either thickly wooded or swampy, but towards the east it becomes much more open, and around the head of Conjuring Creek and along the banks of the White Mud there are some rich grassy prairies, behind which, on the latter stream, there is swampy land thickly wooded with spruce and poplar.

Crossing a high ridge at the head of Weed Creek, on the trail from Pigeon Lake ^{Pigeon Lake.} Edmonton to the old Methodist mission of Woodville, we descend one hundred and thirty feet to Pigeon Lake, the level of which is eighty feet above the country two and a half miles to the north. The lake itself is ten miles long and four miles wide. The water is clear and blue, and contains excellent whitefish and pike. Its outline is rather regular, with high banks, which in all directions but the south-east

rise to hills, one to three hundred feet above its level, thickly clothed with poplar or spruce, though in places near the lake there are a few small clearings, on which comfortable little shanties have been built, and around which some land has been tilled, and is reported to have borne good crops both of roots and cereals.

Battle Lake.

Continuing southward and crossing another high ridge, we descend into a long, narrow valley, in the bottom of which lies Battle Lake, a sheet of clear blue water, five miles long and half a mile wide, and said to contain a great number of whitefish. The beach is usually a firm grey sand, fringed by a narrow margin of rushes, and the middle of the lake appears to be very deep. The south shore rises gradually to a ridge four hundred feet high, thickly clothed with poplar and spruce; the north shore is one hundred and thirty feet high, and covered either with luxuriant grass or with small groves of poplar. At the west end of the lake, on this side, a prominent hill rises to almost as great a height as the ridge to the south, and on it, besides spruce and poplar, some pine (*P. Murrayana*) is growing, while in the valley below is a small grove of tamarac. The valley continues beyond the lake towards the north-west, representing another old drainage channel, in which there is now a watershed.

Bear Lake.

To the east of these two last mentioned lakes, the country is very swampy and rather thickly covered with poplar and willow till Bear Lake is reached. This lake, which is drained north-eastward into Battle River by Bigstone Creek, resembles an extensive marsh with watery centre, surrounded by rather low, rolling and partly wooded hills, which, however, rise a little higher towards the south than in any other direction, and are known as the Bear Hills. East of Bear Lake, a fertile plain stretches away to the banks of Battle River, on which an industrious band of Indians have settled, and now have a considerable area of land under cultivation.

High wooded ridge.

From the east end of Battle Lake, there is a well cut out pack-trail, running south-westward for six miles, at first over a high ridge, thickly wooded with spruce, birch, poplar and some pine, and then across a sandy slope, sparsely covered with small pine, to a wide valley similar to that of Battle River. Its sides are from a hundred to two hundred and fifty feet high, sloping, and very much encumbered with burnt and fallen trees. Its bottom is covered with a mossy bog from a quarter to half a mile wide. At the point where the trail reaches it from the north-east, the valley is drained southward by Blind Man River, but on following it for six miles N. 30° W. we come to a small stream flowing in an opposite direction, finding its way into some of the creeks that flow northward into the Saskatchewan.

Blind Man River.

A short distance south of the twelfth base line, while the bottom of the valley still continues boggy, its western side consists of a sloping prairie stretching back for two or three miles to a ridge of hills, and for five miles down the river. This prairie, covered with luxuriant grass, is watered by several small streams with gravelly beds, and here and there a few dead trunks of pines and spruces are standing, the only remains of the forest which has long ago been destroyed by fire. At one place in the bed of a small stream, this prairie was seen to be underlain by four feet of yellowish sandy loam, beneath which is a bed, twenty feet thick, of small pebbles. South of this plain is an old channel of the river, of a depth varying from one to two hundred feet, and, with a very miry bottom, while the river itself flows a mile and a half still further south in a wide valley, and then turns sharply westward for five miles through a high ridge in a deep-cut, narrow and wooded valley before it joins its waters with those of the West Branch.

Along the southern bank of this portion of the river is a well worn pack-trail, which crosses the main stream just below the junction of the two branches, and then continues over the hill to the west. It, doubtless, leads from the Stoney reserve at Wolf Creek into the forests and hunting grounds around Buck Lake.

The west branch of Blind Man River is formed by the union of West Branch. numerous small streams that rise on the face of a high, wooded ridge four miles north of the twelfth base line, and after crossing that line, flows in a general south-easterly direction for ten miles to its junction with the main stream, through a wide, sloping valley, the bottom of which is generally open, sometimes swampy, and at other times dry and sandy. Six miles below the base line, a stream six feet wide and a foot deep, flows in from the west, draining a wide, sloping valley lying among the hills in that direction. Below the confluence of the two branches, the river continues in the same valley for two miles and a half, and then, although the valley continues on, it leaves it and cuts a narrow gorge through the high ridge to the west, till it reaches another similar wide valley a little further west, down which a small stream is flowing. The sides of this valley are more or less thickly wooded with poplar and spruce, while its bottom is mostly open or covered with small willow scrub. Four miles below the point where the river enters this valley, a small stream joins it from the east, flowing down the valley that the river had left eight miles higher up. For the next ten miles, or to the mouth of Gull Gull Creek. Creek, the valley retains very much the same character, the soil being a rich sandy loam covered with a close coating of long grass. The river runs in a winding channel forty feet wide and ten to

Gull Lake.

twenty feet below the level of the flat. The water is of a light brown colour, and with a slightly marshy taste. Gull Creek joins Blind Man River two miles below the crossing of the eleventh base line. It is five feet wide and a foot deep, with a muddy bed, and flows in a narrow valley thirty-five feet deep. It drains Ki-as-koos Sa-kha-higan, or Gull Lake, which lies three miles to the east. This is a body of clear blue fresh water, eleven miles long and four miles wide, with contour more or less regularly rounded. Its beach is a firm sand or gravel, and on the western side the shore rises quickly into a high, wooded ridge, while to the south and east the beach is skirted by a row of large balsam poplars, behind which is a marsh covered for several hundred yards with grass or willows, beyond which a grassy or partly wooded slope rises to the edge of the thicker timber with which the higher lands are covered.

Medicine
Lodge Hills.

Below the mouth of Gull Creek, the river continues nearly southward for four miles to a short distance beyond the crossing of the old cart-trail from Edmonton to Rocky Mountain House. The channel here is from twenty to thirty feet deep, but the valley is marked only by wide slopes stretching towards the east and west. That to the west is grassy or only lightly wooded with small willow or poplar, and extends for six miles around the south end of the high ridge which has been bounding the valley of the river to the foot of the Medicine Lodge Hills. These constitute a partly wooded ridge rising 675 feet above the river. At the south-eastern corner of this prairie, the river turns eastward and flows for fourteen miles through a deep, narrow valley to join the Red Deer where this latter stream turns sharply eastward through a high ridge in what is locally known as the Cañon.

Medicine River

Travelling along the trail westward from Blind Man River, through a narrow gap in the Medicine Lodge Hills, we reach a wide, shallow valley which is drained southward into the Red Deer by Medicine River. This stream which is said to issue from a lake near the twelfth base line, flows southward, and crosses the eleventh base line in range 4, west of the fifth principal meridian. At this point it is a stream fifty feet wide and two feet deep, flowing over a bed of soft mud, with occasional pebbly bars. The water is rather dark brown, and has a decidedly swampy taste. In it are found a great number of fresh-water mussels (*Unio luteolus*), from which circumstance the Stoney Indians have called it the Mussel River. North of the eleventh base line, the main stream appears to flow in the centre of a wide, partly wooded and probably swampy plain, while a small branch flows in from the west, draining the face of a high range of wooded hills, though here too a narrow belt of boggy land follows the edge of the stream. For five and a half miles south of the base line to the crossing of

West branch.

the Rocky Mountain House cart trail, the banks of the river are from thirty to fifty feet high, and generally grassy, while the surrounding country is rolling, and either grassy or covered with groves of poplar. For six miles south of the cart trail crossing, the country continues of much the same character till the mouth of Horse Pound Creek is reached, which is a stream about half the size of Medicine River, draining a considerable, though at present ill-defined, extent of country east of Raven and Clearwater rivers. Several of its branches, which are crossed by the above-mentioned cart trail, flow through more or less deep, narrow valleys across wide plains, which are generally lightly covered with dwarf birch or willow. Below the mouth of this creek, the valley gradually spreads out till it becomes a wide shallow depression bounded by low, sloping hills, lightly clothed with poplar and willow. The land here is generally covered with dwarf willow, on a rich loamy soil. The river flows in a very winding channel between low, grassy banks, varied here and there by the presence of a few groves of spruce or willow. Traces of beaver are plentiful, old houses and dams being seen wherever there has been sufficient wood to supply them with food and building timber.

Horse Pound
Creek.Fertile slopes
and bottom
land.

SASKATCHEWAN RIVER AND SOME OF ITS TRIBUTARIES.

The Clearwater River rises in one of the inner ranges of the Rocky Mountains, in about lat. $51^{\circ} 40'$, long. $116^{\circ} 15'$, close to the headwaters of Pipestone Creek, which flows south-westward into the Bow River, while the Clearwater River takes a course to the north-east, leaving the mountains in lat. $51^{\circ} 57'$, long. $115^{\circ} 42'$, and eventually emptying into the North Saskatchewan a short distance below Rocky Mountain House. Through the foot-hills, and as far east as the main pack-trail, north from Morley, the banks of the river are reported to be thickly wooded. At the crossing of this trail, the south bank is steep and thickly wooded with spruce and poplar, while the northern side stretches back for about a mile as a wide grassy flat with a few small pine and poplar scattered over it. This flat is one of the famous camping grounds of the Stoney Indians. It stretches for about four miles along the north side of the river, where it is cut off by a bend in the stream. The north side below this is thickly wooded or swampy, the height of the bank decreasing to about thirty feet, while on the south side a flat half a mile to a mile wide, and grassy or covered with very low willow scrub, forms the bottom of the valley. This side of the valley gradually lowers, and then rises abruptly in a hill 150 feet high, beyond which a wide flat stretches for a considerable distance to the

Clearwater
River.Wide alluvial
plain.

south, and is bounded on the east by Swampy Hill (Muskeg-wati, in Cree), along the foot of which a small spring creek (As-kow-i Sī-pī-su) flows northward into the river. The old Blackfoot bridle-trail follows this prairie stretch along the south side of the river, and at the mouth of this creek joins the cart-trail to Rocky Mountain House.

Wooded valley.

Below the mouth of Askowi Creek, the Clearwater turns to the north-west, flowing in a valley for the most part wooded with spruce, while the higher ground to the east is either open and grassy or presents scattered groves of poplar and sometimes also of pine. The river then turns more to the north, and after a further course of eight miles flows into the Saskatchewan, receiving Prairie Creek as a tributary from the west about two and a half miles above its mouth. Opposite the mouth of Prairie Creek is a beautiful grassy meadow, backed by rolling, sandy ridges and fringed along the water's edge by a row of fine poplars.

The Clearwater, at its mouth, is a swift clear stream, one hundred and fifty feet wide and fifteen inches to two feet deep, flowing over a bed of rounded quartzite pebbles. Higher up, the channel is, in many places, divided by numerous wide gravel bars, over which the river, in high water, spreads as a wide, shallow torrent.

Prairie Creek.

Prairie Creek is a beautiful swift stream of clear water, fifty feet wide and nine inches to one foot deep. It rises in the foot-hills north of Clearwater River, and flows eastward to a short distance beyond the Stoney pack-trail, where it turns north for ten miles before emptying into the Clearwater. In this lower portion, which was the only part traversed, it runs in an irregular valley twenty to fifty feet deep, sometimes as much as a quarter of a mile wide with open prairie flats in the bends, and sometimes wooded to the edge of the water. Beaver dams block the streams in many places.

Country
between Clear-
water River
and Prairie
Creek.

Between these streams the country is made up, to a considerable extent, of ridges of yellow sand, having a general north-westerly and south-easterly trend, broken through in many places so as to form isolated hills and separated by marshy ground, in the centre of which the water collects in small lakes or flows in little streams northward into Prairie Creek. These sandy ridges have at one time borne a fine forest of tall straight pine (*P. Murrayana*) from ten to twenty inches in diameter, but all the trees have been killed by fire, and the trunks alone are now standing, covering the ground like a gigantic stubble, while here and there a few small poplar relieve with their green foliage, the dead and wintry appearance of the landscape.

Saskatchewan
River.

The North Saskatchewan rises in numerous streams, which flow from the watershed range of the Rocky Mountains, many of which streams are fed by glaciers of considerable size. Flowing in a general

way to the east of north, it leaves the main range of the mountains in lat. $52^{\circ} 14'$, long. $116^{\circ} 25' W.$, and, after a course of from sixty to seventy miles eastward, is joined by Clearwater River, just below old Rocky Mountain House, from which point we descended it in a boat to Fort Pitt.

Rocky Mountain House, the ruins of an old fort of the Hudson's Bay Company, is situated on an alluvial grassy flat bounded on the south and east by the river and on the north and west by dense forests and swamps. On the south side of the Saskatchewan a similar flat extends for a mile up the Clearwater, though here it is dotted with groves of poplar and willow scrub. The elevation of these flats above the sea was barometrically determined at 3,125 feet. Of the climate we know very little, as the place has been deserted for a number of years, but Dr. Hector, who was there in January 1858, refers to it as follows:—"Sometimes before abandoning the fort in the spring, the Company's servants have planted potatoes and sown barley and turnips, and what was left by the Indians of the resulting crop until their return in the autumn, was sufficient to prove that the soil and climate are very favourable to agriculture. Every day we had here soft winds from the west, which cause a rise in the thermometer, sometimes to even above the freezing point, and the winter is said to be always much milder and the spring earlier than at places further to the eastward."

Opposite the old fort the river is four hundred feet wide, with a still wider bed of quartzite gravel. The water, flowing from glaciers, has quite a milky appearance, while in the Clearwater it is pure and transparent.

At the mouth of this latter stream, the river makes a sharp bend to the north and flows N. $13^{\circ} W.$ for forty-nine miles measured in a straight line. The river in this stretch is swift, and when seen in September had a current of from four and a half to five miles an hour, with a fall of eight feet to the mile, the channel being obstructed by islands and bars of quartzite gravel. For a full description, however, of the valley from Rocky Mountain House to Edmonton, we must refer to subsequent pages of this report.

Edmonton is a thriving town of about nine hundred inhabitants, situated on the north bank of the Saskatchewan, and about two hundred feet above its high-water level. Located as it is, as far up the river as steamboats can depend on being able to reach during the greater part of the season, it has for many years been a chief distributing point for the supply of the Hudson's Bay Company's posts throughout the wide region to the north-west drained by the Mac-

*Journals, &c., relating to the Exploration by Captain Palliser, London, 1863, p. 76.

kenzie River into the Arctic Ocean, and the northern furs are now sent east from there either by boat down the river to Winnipeg or by trail to the Canadian Pacific Railway at Calgary. This trail has recently been surveyed and marked by the Dominion Government; most of the streams crossing it are bridged, and there is a good ferry across Red Deer River; consequently, in fine weather—and for the greater part of the year the weather in that part of the country is fine—it is an excellent highway. Edmonton has also direct telegraphic communication with the east by a line on the old location of the Canadian Pacific Railway, as well as by a line just completed through the more settled country on the north side of the river. A plentiful supply of wood can always be obtained from points higher up the Saskatchewan, but it is not necessary to use wood for fuel, the quantity of coal close at hand being inexhaustible. Mr. Donald Ross has run a drift into the side of the bank immediately below the main street of the town, and is mining a coal of good quality, which, when protected from the weather, will keep for a considerable time, and burns well both in closed stoves and in open grates. Judging by analyses it is equal to much of the coal which is now being so largely mined in Colorado, and superior to that mined at Almy, in Wyoming Territory, where the total output for 1883 is stated at 219,351 tons.*

Coal.

Very fertile district.

Besides its other advantages, Edmonton is in the centre of a district of great fertility, the soil being a rich, deep, black loam that will bear heavy crops of all the ordinary cereals and roots. For these products there is at present a good local market, but should the supply exceed the demand, the farmer could always utilize the surplus in feeding his horses, cattle and pigs, and thus avoid the loss more or less incidental to a purely ranching district.

Fort Saskatchewan.

Below Edmonton, the river flows N. 45° E. for fifty-two miles in a valley from one hundred and fifty to two hundred and fifty feet deep, with sloping, partly wooded, or sometimes scarped sides. In the bottom are wide alluvial intervalles, some of which are occupied and tilled, while others are waiting for the settler. On one of the largest of these, the headquarters of Clover Bar settlement is situated, behind which lie a number of well-tilled farms. Twenty-five miles, by river, below Edmonton, is Fort Saskatchewan, where the high banks recede from the river, leaving a beautiful open bench on either side. On the south side, the Mounted Police barracks are situated, while, on the north side, there is a flourishing settlement, with good, comfortable houses and well-cultivated fields. This is the place selected to bridge the Saskatchewan, on the amended location of the old Canadian

* Mineral Resources of the United States, 1883 and 1884, by Albert Williams. Washington, Government, 1885.

Pacific Railway, before the location was moved still further to the south,* and, certainly, there are few, if any, places between Rocky Mountain House and Fort Pitt, where the river is so accessible and easily crossed.

Near the mouth of Hollow Hill Creek, the river turns and flows eastward for twenty-five miles to the mouth of White Earth Creek. The southern bank is generally high and thickly wooded, while the north side is partly open and slopes gently to the river. There are a few houses to be seen on this slope, a short distance back from the stream, and around them a small area of land is under cultivation. About the middle of the above stretch is situated the Hudson's Bay Company's old post fort of Victoria, now abandoned by the Company, Victoria. but still occupied by an Indian agent and also a missionary of the Methodist Church. At the mouth of White Earth River, which is the most northerly point reached by the Saskatchewan, the river turns and flows a little south of east for one hundred and twenty-one miles to Fort Pitt. The sides of the valley, in this distance, are high and sloping, sometimes open, but generally lightly wooded, and often thickly clothed with berry bushes.

The following poetical description of this part of the river is given by Gabriel Franchère, who in 1814 descended it from Fort George, on his way from the west coast to Montreal:—

“The River Saskatchewan flows over a bed composed of sand and marl, which contributes not a little to diminish the purity and transparency of its waters, which, like those of the Missouri, are turbid and whitish. Except for that, it is one of the prettiest rivers in the world. The banks are perfectly charming, and offer in many places a scene the fairest, the most smiling, and the best diversified that can be seen or imagined: hills in varied forms, crowned with superb groves; valleys agreeably embrowned, at evening and morning by the prolonged shadow of the hills, and of the woods which adorn them; herds of light-limbed antelopes, and heavy colossal buffalo—the former bounding along the slopes of the hills, the latter trampling, under their heavy feet the verdure of the plains; all these champaign beauties reflected and doubled, as it were, by the waters of the river; the melodious and varied song of a thousand birds, perched on the tree-tops; the refreshing breath of the zephyrs; the serenity of the sky; the purity and salubrity of the air; all, in a word, pours contentment and joy into the soul of the enchanted spectator. It is above all in the morning when the sun is rising, and in the evening, when it is setting, that the spectacle is really ravishing. I could not detach my regards from that superb picture, till the nascent obscurity had obli-

Description of
the river by
G. Franchère.

* See Report and Documents in reference to the Canadian Pacific Railway, 1880, pp. 24 and 69.

terated its perfection. Then, to the sweet pleasure that I tasted, succeeded a *triste*, not to say a sombre melancholy. How comes it to pass, I said to myself, that so beautiful a country is not inhabited by human creatures? The songs, the hymns, the prayers of the labourer and the artisan, shall they never be heard in these fine plains? Wherefore, while in Europe, and above all in England, so many thousands of men do not possess as their own an inch of ground, and cultivate the soil of their country for proprietors who scarcely leave them whereon to support existence; wherefore do so many millions of acres, of apparently fat and fertile land, remain uncultivated and absolutely useless? Or at least, why do they support only herds of wild animals? Will men always love better to vegetate all their lives on an ungrateful soil, than to seek afar fertile regions, in order to pass in peace and plenty, at least the last portion of their days?" *

DESCRIPTIVE GEOLOGY.

List of
formations.

The rocks that will be considered in this report exclusive of those that have been deposited in glacial times, are referable to the following formations, a full account of which will be found in the chapter on Systematic Geology:—

Tertiary and Cretaceous.	{	Miocene,
		Laramie, { Paskapoo beds,
		Fox Hill and Pierre,
		Belly River,

TRIBUTARIES OF BOW RIVER.

Cochrane Creek

Eastward from the edge of the disturbed region of the foot-hills, the Bow River and its tributaries drain an area of about four hundred and thirty square miles within the district covered by this report, the tributaries being three small streams which join the main river from the north. Cochrane Creek, the most westerly of these, has a length of about eleven miles, and in low water it averages eight feet wide, and it is eighteen inches deep. In its upper part it flows in a sloping grassy valley which, however, soon becomes deep and narrow, and near its mouth it is wooded with small poplars. No rock was seen in the valley near the crossings of either the Morley-Calgary or the Morley-Edmonton trails.

*Narrative of a Voyage to the North-West Coast of America. By Gabriel Franchère. English translation. New York, 1854, pp. 321-324.

Big Hill Creek, the next stream to the eastward, carries a little ^{Big Hill Creek.} more water than the last, and is about five miles longer, and like it abounds with fine speckled trout. In the upper part of its course it flows southward in an open sloping valley, but soon turns south-westward and flows in a valley a quarter of a mile wide and from two to four hundred feet deep, till it passes the west end of the "Big Hill." In the sides, hard brownish-grey, massive and thin-bedded sandstones ^{Sandstone.} crop out with a light dip towards the west, indicating the east side of a low synclinal which here skirts the edge of the foot-hills before the rocks assume the practically horizontal position which they occupy on the plains.

Nose Creek flows in a wide flat valley, along the sides of which, in ^{Nose Creek.} its lower portion, hard grey false-bedded sandstone crops out, being a continuation of the beds which are exposed near the mouth of the Elbow River, and which clearly belong to the upper portion of the Laramie. At Shaganappi Point, a short distance above Calgary, where essentially the same beds may be seen; Sir J. W. Dawson collected and ^{Fossils in rocks of Paskapoo series.} determined the following species of fossil plants:—*Platanus nobilis*, *P. Reynoldsii*, *Populus genatrix*, *P. acerifolia*, *Sassafras Burpeanum*, *Viburnum asperum*, *V. Calgarianum*, *V. oxycoccoides*.*

On Bow River, opposite the mouth of Fish Creek, in sandstones of the same, or perhaps of slightly greater age, along with *Sequoia Nordenskiöldii*, *Platanus nobilis* and *P. Haydenii*, numerous specimens of *Unio Danæ* (?), *Viviparus Leai*, *Thaumastus limnæiformis* and *Campeloma producta* were found, all of which are common further north in strata ranging from the top of the Edmonton beds to a considerable height in the upper Laramie or Paskapoo beds, which latter name is used as designating all the sandstones and sandy shales of the Laramie newer than the Edmonton or brackish water beds at the base of this formation, and hence as representing not only the Porcupine Hills series of Dr. G. M. Dawson, but also his Willow Creek series, and all but the lowest six hundred feet of his St. Mary's River series, it having been found impossible to trace out or define these three divisions in this section of the country.

RED DEER RIVER AND ITS TRIBUTARIES.

The Red Deer River rises in one of the interior ranges of the ^{Red Deer.} Rocky Mountains, and, flowing eastward, joins the South Saskatchewan near the fourth principal meridian, receiving in the upper part of its course especially, a number of beautiful clear streams,

* On the Fossil Plants of the Laramie Formation of Canada, by Sir J. W. Dawson, Trans. Royal Soc. Can., Vol. IV., Sec. 4, pp. 24-29.

Quartzite
pebbles.

which rise either in the mountains themselves or in the foot-hills which skirt their eastern border. After emerging from these hills, at an elevation of 4000 feet above the sea, and flowing four miles along the edge of Bearberry Plain, a wooded ridge stretches south from the river, showing close to the water's edge a low escarpment of rather hard, coarse-grained grey sandstone, with an intercalated band of dark sandy shale, dipping N. 73° E. < 15°. These sandstones and shales, as far down the river as the outcrop of the twelve-feet coal seam, all belong to the Paskapoo subdivision of the Laramie, so that for that distance it will be necessary merely to notice the general character of the beds. Below the last mentioned point, and as far as the mouth of Fallen Timber Creek, the flats which stretch along either side of the river are underlain by a bed of quartzite pebbles, which have been carried down by the stream from the mountains, and scattered over the bottom of the valley; this bed is covered by a thin deposit of alluvial soil, which now bears a rich growth of grass. Below the mouth of Fallen Timber Creek, for three miles, no rock exposures were seen, the eastern bank being high and wooded, the western, flat and grassy.

The river for the next seventeen miles was not visited by me, but Dr. Hector reports the banks wooded, with shingle terraces up to two hundred and fifty feet above the river.

A short distance above the mouth of Raven River, on the south-east bank, there are several exposures of light-grey, coarse-grained, irregularly-bedded sandstone, in which were found leaves of *Catalpa crassifolia*, and of a species of *Juglans*. Just below the mouth of Raven River, and for three miles along the north side of the river, scarped banks are seen, showing sections, of which the following may be taken as typical, though in the western parts the sandstone largely takes the place of the upper beds:

	FEET.
Section near Raven River.	
Light-coloured, roughly-stratified boulder-clay with numerous boulders.....	5
Stratified sand becoming slightly clayey at the top, and containing a few pebbles.....	7
Rather hard, dark-coloured, unstratified boulder-clay, containing pebbles, none of which are Laurentian, some being fragments of coal. The line between these beds and the preceding is very sharp.....	17
Bed of quartzite pebbles, with soft sandy matrix. The pebbles are lying flat, but there is no other evidence of stratification.....	20
Olive sandy shales and beds of clayey sandstone, with some nodular clay-ironstone, lying almost horizontal or with a slight westerly dip.....	8

In these sandstones and shales at the bend to the east, fragments of a *Unio* and some univalve shells were found. Along the river for nine miles to the mouth of the Little Red Deer, scarpred banks are seen at almost all the convex bends, composed of hardish grey, often false-bedded sandstone, interbedded with olive sandy shales, and in some places with thin beds of marl, made up of the remains of fresh-water shells, among which *Physa Copei*, *Unio*, and *Viviparus* were Fossils. recognized. The bed of pebbles mentioned in the last section is also occasionally seen overlying the sandstone and shale. East of the mouth of the Little Red Deer, is a beautiful flat prairie, underlain with a bed of shingle similar to that forming Bearberry Prairie at the mouth of Fallen Timber Creek. Below the mouth of Medicine River, an exposure of horizontal grey sandstone again occurs on each side of the river, and then the banks fall away till the northerly bend is reached, when they again become high and scarpred for a short distance. The beds for thirty feet above the water are coarse sandstones and shales, above which there is a thin band of lignite, and then, again, sandstones and shales pierced by what, no doubt, have been roots of trees, and containing numerous fragments of fossil leaves, among which *Sequoia Nordenskiöldii* and *Viburnum asperum* were recognized. Beyond this, the banks are mostly sloping, grassy on the west side and wooded on the east; the stream is not rapid as before, and is obstructed here and there with wooded islands.

A short distance below the crossing of the Edmonton-Calgary trail, on the west side of the river, there is a considerable exposure of Paskapoo sandstone and shale, overlain by the pebble bed and lower Paskapoo sandstone. boulder-clay. Above the latter, is a bed ten feet thick of light-coloured hard stratified clay, in some cases almost shaly, forming a projecting ledge along the top of the bank. The lower boulder-clay Lower boulder clay. is here eighteen feet in thickness, and is intersected by numerous jointage planes, which cause its exposed surfaces to weather in columnar or prismatic shapes. It is composed of hard dark-coloured sandy clay, containing a few pebbles mostly of light-coloured quartzite, though some of gneiss were also observed, and there are also scattered through the matrix a large number of small angular fragments of coal, to the presence of which the prevailing dark colour of these beds is due.

In the sandstone at the foot of this bank, limestone nodules were found, in which are included remains of *Goniobasis tenuicarinata* and *Hydrobia*, sp. These limestone nodules were examined by Mr. Limestone nodules. Hoffmann of this survey, and were found by him to yield, when burnt, a very good lime.

Below this, to the mouth of the Blind Man River, the banks are composed of horizontal light-grey sandstones, and grey and olive

shales, and in almost all the escarpments, fragments of fossil shells were found. At a mile, measured in a straight line, above the mouth of Blind Man River, there is a scarped bank showing forty feet of sandstone and shale. Near the top, and under a thick band of hard sandstone, is a thin dark shaly band, containing fossils. About five feet below it is a two-inch seam of coal, and close to the water's edge, there is a bed of marlite from one to three inches thick, made up of fragments of fresh water shells, among which *Viviparus Leai* and a *Unio* were detected, as well as some fragments of the jaws and other parts of fishes. At the mouth of the Blind Man River, the following section is seen:—

Mouth of
Blind Man
River.

	FEET. INCHES.	
Thick-bedded sandstone.....	10	0
Olive shale.....	15	0
Hard flinty sandstone.....	0	3
Coal.....	0	1
Sandstone and shale.....	3	0
Carbonaceous shale.....	0	8
Grey sandstone (to water's edge).....	3	0
	52	0

For twenty-one miles below the mouth of Blind Man River, the Red Deer flows in a deep valley, with beautiful alluvial intervalles, the sides gradually becoming lower and more sloping, but they are occasionally scarped and then show coarse-grained sandstone, and light-coloured sandy shale, dipping slightly towards the west.

About the middle of range 24, a seam of coal is seen cropping out at the water's edge, overlain by a bed of soft, coarse-grained, light-coloured sandstone, in which some silicified wood is included. A quarter of a mile further down the river, the same seam is seen, showing the following section:—

Coa

	FEET. INCHES.	
Coal.....	5	0½
Carbonaceous sandstone.....	0	4
Carbonaceous shale.....	1	7
Coal.....	1	3
Shale.....	0	10
Coal.....	2	0
Shale.....	0	2
Coal.....	1	4
Clay.....	0	2
Coal.....	0	6
Clay.....	0	1
Total.....	13	3½
Total Coal.....	10	1½

This seam occupies the same geological position as the Big Coal Seam on the Saskatchewan River further north, namely, the top of the clays and sandstones of the Edmonton subdivision of the Laramie, and it is not improbable that it is a continuation of the same seam. Its extension to the north will be considered later on in this report.

The seam is underlain by a soft coarse-grained sandstone containing an irregular seam of clay-ironstone one foot thick; and all the way to the mouth of Tail Creek, a distance of eighteen miles, similar sandstones, with a light dip westward, crop out at the outer side of the curves of the river. The banks are generally grassy or wooded, and the above mentioned coal seam gradually rises to the top of the bank, its presence being indicated, in many places, by red ashes and cinders, while other seams, of very small thickness, are exposed under it. In the valley of Tail Creek, the whitish clayey sandstones of the Edmonton series are occasionally exposed, and all along the valley of the Red Deer as far as the mouth of Rosebud Creek, excellent sections of these rocks can constantly be obtained. Two miles below the mouth of Tail Creek, on the east side of the river, the bank is three hundred feet high, and is composed of grey and olive sandy shale and clayey sandstone, with some thin seams of coal. Two hundred feet from the top there is a layer of ironstone nodules, containing numerous fragmentary impressions of leaves, among which *Trapa borealis* and a species of *Salisburia* were recognizable. A short distance lower down on the opposite side of the valley, there is a cut-bank of similar shale and sandstone, showing an irregular seam of coal, and two miles further down on the west side, is a cliff largely composed of sandy shale, but a coal seam is exposed thirty feet above the water, which shows the following section:—

	FEET. INCHES.		
Coal	0	3	Coal.
Dark sandy clay.....	0	2	
Coal	1	1	
Dark sandy shale	1	6	
Coal	2	4	
Plastic clay shales	0	4½	
Coal	0	11	
Dark sandy shale	4	7	
Coal	1	9	
Grey sandy shale	1	5	
Coal	1	2	
Sandy shale.....	0	3	
Coal	3	0	
Total	18	9½	
Total of Coal.....	10	6	

Analysis.

Specimens of the lower part of this seam have been analysed by fast coking, by Mr. Hoffmann, with the following results:—

Hygroscopic water.....	10·02
Volatile combustible water	32·11
Fixed carbon	45·19
Ash	12·68
	<hr/>
	100·00

Coke, non-coherent.

Petroleum claims.

Between these two last mentioned escarpments, but on the opposite side of the river, several claims have been taken up by gentlemen who were under the impression that petroleum was to be found here, and it has even been asserted that it is to be seen covering the river for a considerable distance below this point. In two separate examinations in the early summer and in the autumn, I could not discover any traces of petroleum, and Mr. Hoffmann examined in the laboratory of the Survey, but with no better success, specimens of clay and sandstone, which were brought tightly sealed from some of the claims. On one of these there is a spring trickling out of the bank and where the water reaches the flat several small pools are formed which dry up in the autumn, leaving a glistening black deposit, which looks something like gum, and which forms, when shaken up in water, a rich brown sepia-like pigment. In the bank is a seam of lignite, and the black gum-like substance is composed of the fine soft clay which occurs in thin seams with the lignite, and which is stained by a brown colouring matter that has been dissolved out of the lignite by the water of the spring flowing through it.

For seventeen miles down the river light-coloured sandstone, with included thin seams of coal, is seen, at intervals, overlain by light-coloured boulder-clay. Where the stream turns to the south-west, bad-land buttes begin to stand out in the valley, and at this point Dinosaurian bones are met with for the first time in considerable numbers. The following section obtained here can be taken as fairly characteristic of the rocks of the Edmonton series, as exposed in the river banks as far south as the mouth of Rosebud Creek:—

	FEET. INCHES.	
Characteristic section.	Light-coloured boulder-clay including many Laurentian boulders and pebbles—at least.....	10 0
	Whitish clayey sandstone.....	20 0
	Grey carbonaceous shale.....	12 0
	Coal (burnt out).....	2 4
	Whitish clayey sandstone.....	15 0
	Coal (a brown lignite).....	2 3

	FEET.	INCHES.
Light-grey sandy shale, with six-inch band of ironstone near the top.....	25	0
Yellow sandy shale	6	0
Shale mixed with <i>coal</i>		0
Grey readily weathering sandstone with irregular masses of ironstone and reptilian bones....	60	0
Lighter grey sandstone	5	0
Sandstone and ironstone	1	0
Light-grey rather hard sandy shale with irregular bands of ironstone.....	25	0
Layer of nodules of flinty ironstone containing impressions of plants.....	0	6
Light sandy shale.....	10	0
Hard ferruginous sandstone containing obscure plant impressions.....	2	6
Light-grey sandy shale.....	6	0
Rather hard lamellar sandstone.....	1	0
Light-grey shaly sandstone containing, especially in the lower portion, more or less irregular bands of ironstone nodules.....	110	0
	315	7

For the whole of the distance to the mouth of Rosebud Creek—forty-eight miles—the valley is from three to five hundred feet deep, with sides of horizontal sandstones and clays, such as those described in the above section. Seams of coal appear, run along for a short distance, and then die out. Great numbers of Dinosaurian bones are scattered through the rocks underlying this part of the country.

At the mouth of Rosebud Creek, a low bank near the water's edge shows the following section:—

	FEET.	INCHES.
<i>Coal</i>	0	8
Reddish shale.....	5	0
Compact <i>coal</i>	6	10
Sandy shale with thin bands of sandstone.....	8	0
White clayey sandstone.....	1	0
Greyish sandy shale.....	7	0
<i>Coal</i>	1	3
Grey shale	to water's edge	

Mr. McConnell, who traversed the river from this point down to its mouth, in 1883, examined this seam, and refers it to the same horizon as the coal seam at Blackfoot Crossing, placing it at about one hundred and sixty feet above the Pierre.*

* Geol. Survey Report for 1882-84, p. 95 c.

An analysis of it was made by Mr. Hoffmann, with the following result:—

	<i>Slow Coking.</i>	<i>Fast Coking.</i>
Hygroscopic water.....	13·08	13·08
Volatile combustible matter.....	31·49	34·50
Fixed carbon.....	51·35	48·34
Ash	4·08	4·08
	100·00	100·00
Indicated power of fuel in calories....	—	5347

TRIBUTARIES OF RED DEER RIVER.

Fallen Timber
Creek.

Sandstone and
sandy shales.

In descending Red Deer River, the first affluent of any considerable size, is Kow-ich-ti-kow or Fallen Timber Creek, which rises on the eastern face of the Rocky Mountains, and reaches the eastern edge of the foot-hills at an elevation of 4,200 feet. A few rock exposures are to be seen on the stream, the first being in the north-east corner of township 30, range 6, west of the fifth principal meridian, where light grey sandstones and sandy shales of the Paskapoo subdivision of the Laramie, crop out, dipping N. 70° E. < 10°. Again at the northern bend of the creek there is an exposure of fifty feet of light-grey sandstones underlain by light-grey sandy shales. The lower part of the valley is open and swampy, but about a mile above the junction of the stream with the Red Deer, a low ridge runs out from the west, exposing thirty feet of rather hard, coarse, grey sandstone and sandy shale, dipping 3° to the north-west. Lying against this sandstone ridge and extending on both sides of it is a bed of quartzite pebbles, three feet thick. In one place it is seen lying directly on the sandstone. It continues north across the Red Deer to Bearberry Creek, and also from the western edge of the foot-hills to the ridge east of the mouth of Fallen Timber Creek, and then for several miles north along the Red Deer River, forming a plain covered on the north side of the Red Deer with excellent bunch-grass and on the south side with dwarf birch and willow. This evidently, has, in comparatively recent times been the site of a shallow lake or of a wide shallow expansion of the river, into which the quartzite pebbles derived from the mountains or perhaps more directly from the higher benches in the upper parts of the valley, were carried and deposited evenly over its bed, while the lighter sediments were carried still further down the stream.

† Loc. cit., p. 15 M.

Passing over Bearberry Creek and several other small streams, we come to James River or the North Fork, which flows into the Red Deer from the west. It is the outlet of some small lakes in a gap in the outer range of the mountains, and after a course of about forty miles unites its waters with those of the Red Deer River. At the crossing of the old Blackfoot pack-trail to Rocky Mountain House, it is sixty feet wide and one foot deep, flowing over a bed of quartzite pebbles. The valley is fifty feet deep and from a quarter to half a mile wide, its bottom being a grassy sward underlain by two to three feet of rich alluvial soil resting on a bed of quartzite pebbles. Beyond this point the valley of James River has not yet been examined. Coal is reported to occur in large quantities further up the stream, but the exact position and extent of the deposit is as yet unknown, though in all probability it is within the disturbed foot-hill belt. Coal reported.

North and north-east of James River, Raven River drains a considerable extent of swampy and wooded country, though only one of its branches, namely, that which is followed by the trail from Calgary to Rocky Mountain House, has as yet been examined. This stream rises in a marshy flat near the bend of Clearwater River, and flows south-east through a sloping, grassy or lightly-wooded valley, the sides of which rise in clay or gravel terraces to the hills behind. It is probable that the Clearwater at one time flowed to the south through this valley to join the Red Deer, but the gradual southern elevation of the country, assisted doubtless by a temporary blocking up of the old channel, diverted its waters to the north, causing them to carve out the narrow valley through which they flow to join those of the Saskatchewan. Raven River.
Old terraced valley.

Little Red Deer River flows into the Red Deer fourteen miles below the mouth of Raven River. It rises in the eastern range of the Rocky Mountains and leaves the foot-hills in lat. $51^{\circ} 30'$, long. W. $114^{\circ} 41'$, at an elevation of 4,000 feet, cutting a narrow gorge through a sharp anticlinal of Laramie sandstones. Below this the valley is sloping, with a bottom underlain with quartzite gravel, and rises in two or three terraces to the level of the surrounding country. Very few rock exposures are to be seen, and those that appear through the sod are light-grey sandstones and sandy shales dipping north-easterly at a gradually decreasing angle. Following the river through the wide swampy valley to the point where it turns sharply to the east a little south of Hawk Hill, in lat. $51^{\circ} 49'$, an exposure occurs which shows about one hundred feet of horizontal, light-grey and yellowish, rather hard sandstone, interstratified with greyish-green sandy shales, and which represents an horizon high in the Paskapoo series. Six miles further down and a short distance below the mouth of Dog Pound Creek, true boulder-clay was seen for the first time in descending the river but Little Red Deer River.

Superficial
deposits.

in less than a mile, all three divisions of the superficial deposits were met with, the following being the section exposed :

	FEET.
Light-coloured clay containing but few boulders	12
Dark-coloured boulder-clay	12
Quartzite pebble bed (to water's edge)	15

Pre-glacial
valley.

As the banks both above and below this are composed of the sandstones and shales of the Laramie, the presence of the regular beds of boulder-clay would indicate the existence of a pre-glacial valley, which, however, was not filled up to the level of the surrounding country. Other exposures of boulder-clay are seen on the north side of the river ; in one place thirty feet of light-coloured sandy boulder-clay, with numerous boulders of quartzite and sandstone, is exposed under eight feet of light-coloured, obscurely stratified sandy clay.

On the south side of the valley, as far down as the crossing of the Rocky Mountain House trail, light-grey and greenish sandy shale, intercalated with bands of ferruginous sandstone, crop out at intervals ; and at the crossing of the trail, where the valley is seventy-five feet deep, these sandy shales are overlain by quartzite gravel in a matrix of sandy clay. Along the remaining part of the course of the Little Red Deer down to its mouth, a distance of fourteen miles, no rocks were seen, the bottom of the valley being flat and swampy while the sides rise gradually to the surrounding plain.

In some of the small valleys that are found on the northern side of the ridge separating the waters of the Bow from those of the Red Deer, and that are drained by streams flowing into Dog Pound Creek, some low exposures of horizontal sandstone occur, but in the valley of this stream between the mouth of Rock Creek and the Little Red Deer, no rock is seen in place, the only exposures met with being low cut-banks of stratified sand. West of the head of the Dog Pound, the country lying between the Bow and Ghost rivers and the Little Red Deer consists of a series of high ridges composed of sandstone more or less vertical, separated by swampy valleys, underlain, at least wherever the rocks were seen, by soft dark shales.

Medicine
River.

A mile below the mouth of Little Red Deer River the Medicine River joins the Red Deer from the north. It rises on the face of a range of hills separating the drainage area of the latter river from that of the North Saskatchewan, and, after a course of sixty-five miles, empties into the Red Deer in a stream forty feet wide and two feet deep.

On the upper part of the main branch, the bottom of the river is a soft sand, and the banks for the most part are a light-yellow sandy clay holding some pebbles ; this clay is, in places, of glacial origin, but

in most cases, especially close to the channel of the creek, it is derived from the degradation of boulder-clays and Laramie clays and sandstones. Near the trail-crossing of the west branch or Horse Pound Creek, under ten feet of fine yellowish sand there are thirty feet of light-grey thin-bedded sandstone and sandy shale, below which to the water's edge there are eight feet of light-grey compact sandstone. Further down along this branch, outcrops of similar sandstone and shales occur at intervals and at its mouth there is a low exposure of horizontal, soft, yellowish-grey, false-bedded sandstone, similar to that seen at the trail-crossing of Rosebud Creek, as well as in some high cliffs on the Saskatchewan thirty-five miles below the mouth of the Brazeau River. Sandstone cliffs

Below the Forks, the river flows in a wide, gently sloping valley, the bottom of which is covered with a moderately thick layer of a sandy superficial deposit.

On the east side of the valley of Medicine River, a high ridge separates it from the valleys of the Blind Man and Red Deer rivers. This ridge starts abruptly in township 41, range 3, in a rounded and partly-wooded hill, 450 feet high, and with an elevation of 3,500 feet above the sea, and runs S. 40°. E. till it gradually falls to the level of the surrounding country. It is cut through by several narrow transverse valleys which, though now dry, have all the appearance of having been the channels of ancient streams. Along the edge of this ridge, from bottom to top, horizontal bands of hard, grey, thin-bedded sandstone are seen projecting through the superficial covering of sandy clay, which is derived from the wearing away of the sandstones and, doubtless also, shales beneath. But, though there appears to be little or no true boulder-clay on the higher parts of the ridge, its surface up to its very summit, is scattered over with a large number of boulders, Laurentian boulders. two-thirds of which are of gneiss, and, doubtless, derived from the east or north-east, presenting every appearance of having been dropped from ice which had stranded on this sandstone hill, then a shoal or bank in the glacial sea.

The ridge to the west of Medicine River is one hundred and fifty feet higher than the one just mentioned, and on it, too, a great many Laurentian boulders are scattered, perhaps, up to its summit, though none were noticed till we had descended two hundred feet.

Thirty-five miles below the mouth of Medicine River, Blind Man or Paskapoo River flows into the Red Deer from the north-west. The Blind Man River. eastern of its two main branches rises in a wide, sloping valley, with low, swampy bottom, while the western branch is fed by small streams that flow from the face of the ridge that forms the watershed between the Red Deer and North Saskatchewan rivers. The stream

Paskapoo
sandstones.

flows through its whole course of sixty-two miles over rocks of the Paskapoo or upper sub-division of the Laramie. On the west branch, a mile and a half above where the east branch joins it, the following section is seen:—

	FEET. INCHES.	
Dark grey sandy clay containing a few small pebbles of quartzite with occasionally one of gneiss.....	6	0
Coarse yellow sandstone running into a yellow ferruginous sandy shale.....	8	0
Olive-green clayey shale.....	6	0
Impure lignite.....	0	5
Similar olive shale.....	2	0
Greenish-yellow, rather hard, much-fractured sandstone containing nodules of hard, fine-grained, compact sandstone...	5	0
Bluish-grey fine clay-shale.....	2	0
Alternating bands of bluish and greenish clay-shale and soft sandstone with occasionally rounded nodules of hard sandstone.....	30	0
	<hr/> 59	<hr/> 5

A mile and a half further up-stream, the seam of lignite is again exposed, underlain by eight feet of greenish and grey clay shale. From this exposure down the stream to the crossing of the Rocky Mountain House trail, a distance of twenty-seven miles, very few rock exposures are met with, and what are seen consist of such light-grey sandstones and sandy shales as are common throughout the formation. At the crossing, the following section may be seen:—

	FEET.
Rather hard, compact, light yellowish-grey sandstone....	6
Grey, thin-bedded, rather hard sandstone.....	6
Light-bluish sandy shale, including large irregular limestone concretions.....	15

Limestone
concretions.
with fossils.

In these limestone concretions, are numerous and often well-preserved specimens of the following species of fossils:—

Sphaerium formosum ?, var., *Physa Copei*, *Hydrobia*, sp., *Campeloma producta*, *Viviparus Leai*, *Valvata filosa*, *Valvata bicincta*, tooth of shark like *Oxyrhina*.

From the Rocky Mountain House trail to the mouth of the river, a distance of sixteen miles, coarse-grained sandstone, interstratified with sandy shale, crops out at intervals. Three quarters of a mile up-stream from the Red Deer, a six-inch seam of coal crops out forty feet above the bed of the stream, underlain by a thin bed of marly sand, in which the following species of fossils were collected:—

Fossils.

Limnæa tenuicostata, *Physa Copei*, *Acroloxus radiatulus*, *Valvata filosa*, *Valvata bicincta*, and fragments of *Hydrobia* and *Sphaerium*.

The mouth of this river is approximately a hundred feet higher than the outcrop of the twelve-foot coal seam on the Red Deer River twenty miles further down the stream, and as the rocks in this distance have a light dip westward of five to ten feet to the mile, the maximum height of the bottom of the rocks here exposed may be taken as three hundred feet above the coal seam, which is at the top of the Edmonton series.

WESTERN DRAINAGE AREA OF THE RED DEER RIVER.

In descending Rosebud Creek the first rock exposures met with Rosebud Creek. are on a small creek running in from the south, half way between the Morley and Calgary trails. They consist of rather hard, coarse-grained, yellowish-grey sandstone, standing out from the grassy hill-sides, and weathering into curiously pillared shapes. They are thick-bedded, and horizontal, but exhibit false bedding dipping at every conceivable angle. Two miles and a-half further down the valley, other exposures were seen, shewing light-grey sandy shale and sandstone with some included limestone nodules containing *Viviparus Leai*. At the crossing of the Calgary-Edmonton trail, coarse-grained, soft, yellowish and whitish sandstones crop out in the side of the valley, and close to the edge of the creek, under about two feet of thin-bedded sandstone, a thin seam of powdery lignite can be detected, underlain by a soft yellow sandstone with nodular clay concretions. On the Calgary-Edmonton trail southward as far as the Sharp Hills, thick-bedded, rather hard, light-grey sandstone is seen to Sharp Hills. crop out in the valleys of small creeks, and in the Sharp Hills, coarse, light-coloured, thin-bedded sandstones are seen projecting through the soil. The hills are strewn with numerous boulders, mostly quartzitic, but a few are gneissoid. On the Rosebud, for two miles below the trail-crossing, false-bedded, pillared sandstones, similar to those already Pillared sandstones. described, are seen in small exposures, though the banks are mostly grassy; and again six miles further down, under a bed of laminated sandstone, there is an outcrop of thirty feet of light-grey clay-shale, here and there stained with iron, and four miles lower, false-bedded sandstone re-appears similar to that seen near the Calgary-Edmonton trail.

In the flat through which the river runs for several miles after it bends to the east, low banks of white sandy clay skirt the stream, and where the valley again contracts to its usual width, eighty feet of white stratified clay with some thin bands of sand and a few included pebbles of quartzite and gneiss, appear on the north side of the valley. Half a mile below this, some fragments of sandstone were found in the bed of the creek, containing beautifully preserved specimens

of *Thaumastus linnaeiformis* with fragments of *Ostrea*, *Viviparus trachaeiformis* ? and carbonized fragments of fossil wood. The sides of the valley, for the next eighteen miles, are composed of clay and are sometimes abruptly scarped close to the bends of the stream. The following may be taken as typical sections: In a bank forty feet high, the upper fifteen feet are composed of white laminated clay, without pebbles, running down into a soft shaly clay underlain by sandy clay containing pebbles of quartzite and rounded fragments of coal; and again in a bank eighty feet high :—

Sands and clays

	FEET.
White laminated clay.....	15
Thick-bedded compact clay.....	12
Sandy clay with boulders.....	15
Stratified sand, the grains being somewhat rounded.....	38
	<hr/> 80

A short distance below the mouth of Service Berry Creek of the Dominion Lands map of 1884, the underlying rocks re-appear, the following section being exposed :—

	FEET.	INCHES.
White laminated clay, at the top.....	..	..
Sandy conglomerate or boulder-clay.....	20	0
Irregular seam of coal.....	0	1
Whitish sandy conglomerate or boulder-clay, the pebbles being few and small.....	4	0
Rather hard clayey sandstone.....	8	0
	<hr/> 32	<hr/> 1

Edmonton series.

This latter bed is the first outcrop seen in descending this stream belonging to the Edmonton or coal-bearing subdivision of the Laramie, the rocks met with above it belonging all to the Paskapoo or upper subdivision.

Half a mile further east, at the mouth of a small creek which flows in from the south, under the laminated clay, is a bed of clay including boulders, and under it a reddish sandstone passing downwards into a sandy clay which contains ironstone nodules and fragments of reticulate leaves, among which *Trapa borealis* was recognizable. A mile further down the stream, the following section was observed :—

	FEET.	INCHES.
Laminated clay, at the top.....	..	..
Clayey sandstone.....	20	0
Coal.....	1	6
Clayey sandstone, with a layer of septarian ironstone nodules.....	30	0

From this point to the mouth of the creek, the valley gradually increases in depth, the sides become more naked and abrupt and steep bare conical hills or "buttes" of the banded clay and sandstone often stand in the middle of the narrow gorge, having been detached from the face of the high bank by the action of atmospheric agencies, assisted to some extent by the rapid stream below. A number of excellent sections of the rocks of the Edmonton series are here to be seen, consisting, for the most part, of light-grey or whitish argillaceous sandstone, rather coarse-grained, and lying in thick compact beds. These are interstratified with thick beds of light-grey sandy shale, and occasionally with thin seams of coal or of carbonaceous shale. The greatest thickness observed in any of these coal seams was two feet, and even that varied in a short distance. Beds of impalpable clay were also observed, very similar to that collected by Dr. Selwyn at Edmonton, in 1873, and determined by Dr. Harrington as a hydrated silicate of alumina.* The beds have a light westerly dip of about twenty-five feet to the mile, which will give a total thickness of about 750 feet for the rocks exposed along the creek in the lower fifteen miles of its course. The following section, which was seen five miles above its mouth, may be taken as typical:—

	FEET. INCHES.		Typical section.
Clayey sandstone and clay-shale.....	70	0	
Carbonaceous shale.....	0	6	
Light-grey clayey sandstone and clay-shale.....	8	0	
Layer of hard sandstone.....	6 inches to	2	0
Clay shale with ironstone.....	4	0	
Coaly shale.....	1	0	
Light-grey clay-shale.....	1	3	
Coaly shale.....	1	4	
Clayey sandstone and clay-shale.....	15	0	
Coal.....	1	2	
Clayey sandstone and clay-shale.....	46	0	
Coal.....	0	6	
Clayey sandstone and clay-shale.....	20	0	
Coal, moderately compact.....	2	0	
Clayey sandstone and clay-shale with ironstone...	13	0	
Impure coal.....	1	3	
Clayey sandstone and clay-shale with ironstone....	14	0	
Carbonaceous shale.....	0	4	
Coal.....	1	10	
Clay-shale.....	9	0	
	212	2	

Knee Hills
Creek.

On Knee Hills Creek twenty mile due east of the bridge across Rosebud Creek, and at an elevation of 2850 feet, hard grey, in places brownish-weathering, sandstones crop out along the sides of the grassy bank of the valley, and a short distance to the south, in the valley of a small stream flowing in from the west, twenty feet of rather soft, light-grey coarse-grained sandstone, shaly in places, overlain by six feet of light-grey clay containing a few pebbles mostly of quartzite, but some few of gneiss, are exposed. The grey and brownish sandstones crop out in the valley at irregular intervals for thirteen miles, where the following section is seen:—

	FEET.
Brownish thin-bedded sandstone.....	10
Somewhat soft grey sandstone with large rounded masses of coarse-grained ferruginous sandstone.....	8
Olive sandy shale	10

Four miles further down the creek, the following section is seen:—

	FEET.
Rather hard, brown, false-bedded sandstone.....	12
Olive sandy shale.....	40
Hard ferruginous sandstone.....	6
Grey and olive sandy shale and sandstone	25
Beds concealed	25
Dark friable clay-shale, at water's edge.....	..
	<hr/> 108

Below this, for two miles, the sides of the valley are sloping and grassy, being no doubt composed of the last mentioned shale, till grey sandy clays again crop out. At a short distance further down the stream a seam of coal is seen at the water's edge, and a mile and a quarter below the following section is exposed:—

	FEET.	INCHES.
Whitish clayey sandstone.....	30	0
Clay-shale.....	1	6
Coal (compact).....	4	0
Carboniferous shale mixed with lignite.....	0	10
Rather hard clayey sandstone turning into clay- shale at the top.....	25	0

The above mentioned whitish sandstone is the first of that nature seen in descending the stream. It is at the top of the Edmonton subdivision of the Laramie adopted in this report, and doubtless occupies the same position as the "light-coloured argillaceous sands" recorded by Mr. McConnell as occurring near the top of the

Wintering Hills,* and underlying sixty feet of dark, plastic clays, these latter being doubtless represented by the dark clay-shale found occurring at the water's edge in the section on Knee Hills Creek. The coal mentioned in the last section occurs in a compact seam, breaking off into rectangular masses of considerable size. It has been examined by Mr. Hoffmann, the chemist of the Survey, who reports that "it is a lignite of superior quality; becomes somewhat fissured by exposure to the air, but might be kept for a short time in a sound condition if protected from the weather; when freshly mined is, in all probability, a firm fuel, and would bear transport to moderate distances. A proximate analysis of a sample collected from this seam gave—

Hygroscopic water.....	9.86
Volatile, combustible matter.....	34.89
Fixed carbon.....	46.57
Ash.....	8.68
	<hr/> 100.00

Apart from the structure being somewhat more coarsely lamellar, it is not very dissimilar to specimens 6 and 7 of Report for 1884, pp. 15 and 16 m." On descending the valley, the coal seam is seen to rise at the rate of about twenty-five feet to the mile. Mr. McConnell states that a thin seam of lignite is met with in the Wintering Hills in connection with the "light-coloured argillaceous sands" above mentioned, and in all probability it is the continuation of the same seam. The extension northward of this seam will be considered more fully on a succeeding page of this report. Down the stream, exposures become more numerous as the valley becomes deeper and more precipitous, the banks being composed of grey and whitish soft clayey sandstone and grey sandy shale, with bands and nodules of ironstone. In some of these nodules, which were found in a bed of soft sandstone outcropping about eight miles above the mouth of the creek, well-preserved specimens of *Unio Danæ* and *Panopæa simulatrix*, and, a short distance further down, a long bone from one of the extremities of a Dinosaur was found imbedded in a large block of ferruginous sandstone. Similar shales and sandstones continue to form the banks of the valley to its junction with that of the Red Deer. Several thin seams of coal run for short distances as black horizontal bands between the thick beds of white clay and sandstone, giving, with the reddish ferruginous bands of somewhat similar thickness, an exceedingly variegated and often picturesque appearance to these bare

*Geol. Survey Report for 1884. p. 93.

Dinosaurian
remains.

rocky hill sides—an appearance which induced Dr. Hector, in 1859, to apply the name “Banded Clays” to this portion of the Laramie. Two miles above the mouth of the creek, where the Blackfoot pack-trail crosses the valley, similar rocks are exposed, and in a bed of the whitish sandstones the head of a large carnivorous Dinosaur was found, which is stated by Prof. Cope to be the largest Dinosaur yet found in the Laramie, and to be allied to his Cretaceous species, *Laelaps incrassatus*.

The ridge which rises between Knee Hills and Rosebud creeks is deeply cut by numerous coulees, which lead down into the valleys of either stream, and show in many places excellent sections of the Edmonton series, though, in a few places, the bottom beds of the next succeeding subdivision are also slightly exposed. A number of the coulees which run northwards have water in them at almost all seasons of the year; a few clumps of poplar grow along their sides, and they would afford abundant shelter for large herds of cattle, both from the direct rays of the sun in summer and from the storms of winter, while there would always be a plentiful supply of nutritious grass on the surrounding plateau.

Three Hills
Creek.

Paskapoo series

In the upper portion of Three Hills Creek, where it runs in the bottom of a wide grassy valley, no exposures of the underlying rock were met with, the banks being composed of stratified sand and gravel. In the Knee Hills, however, which rise to the west of the creek, croppings of hard grey sandstones, belonging to the Paskapoo subdivision of the Laramie, are seen. Directly east of the southern end of these hills at an elevation of 2,600 feet, grey and olive sandy shales and hard, coarse-grained grey brownish-weathering sandstone crop out close to the creek. Five miles further down, forty feet of similar shales and sandstones occur under thirty feet of sandy, stratified, boulder-clay, overlain by eight feet of stratified yellowish clay. In the sandstone are bands of somewhat bituminous, sandy shale, containing numerous fragments of fossils, among which may be mentioned the tooth of a Dinosaur, *Sphaerium*, *Valvata*, *Unio*, *Goniobasis*?, opercula of *Viviparus*, and carbonised stems of plants, and in some blocks of sandstone at the bottom of the bank, *Campeloma producta* and *Thaumatococcus limnæiformis*. The latter of these species has not been found actually in place within the limits of this map, but in the summer of 1885, it was found on the banks of the River opposite the mouth of Fish Creek, associated with *C. producta*, *Viviparus Leai*, and fragments of a *Unio*.

Edmonton
series.

Four miles above the mouth of Devil's Pine Creek, whitish clayey sandstones begin to appear in the sides of the valley, overlain by a bed of dark clay shale. Under a thickness of twenty-five feet of the sandstone, a seam of compact coal two feet two inches thick is exposed,

forming the continuation of the four-feet seam on Knee Hill Creek, though the beds here seem to have a slightly higher westerly dip than at the last named place. The white clayey sandstone and sandy shale form the sides of the valley to its mouth, and the following section which is shown at the Forks of Devil's Pine and Three Hills creeks, will be typical for the whole distance.

	FEET. INCHES.	
Rather hard, light-brown sandstone, at the top....	..	..
Light-grey and whitish sandstone and sandy shale, with some ironstone.....	100	0
Coal	0	8
Similar sandstone and shale, with ironstone nodules and ferruginous sandstone in which was found <i>Corbicula occidentalis</i> and <i>Panopæa curta</i>	100	0
Coaly shale	1	6
Coal	1	0
Carbonaceous shale.....	..	..
	203	2

Fragments of Dinosaurian bones and some plant remains, among which were fruits of a species of *Carpolithes* were found at the bottom of the bank.

Devil's Pine Creek, where it flows from Devil's Pine Lake, runs over a gravel bed, in a valley with sloping grassy sides. Where next met with, fourteen miles further down, it runs on a muddy bottom in a wide, sloping valley, and the stream was followed for four miles before any croppings of the underlying rocks were seen. The exposure consisted of—

	FEET. INCHES.	
Light coloured boulder-clay, at the top.....	..	..
Coal.....	1	6
Light-coloured clay-shale.....	10	0
Coal.....	0	3
Light-coloured clay-shale, at the bottom.....	..	..

For the next fourteen miles the sides of the valley are composed of superficial sands and clays underlain by the yellowish stratified clay and the dark-coloured columnar boulder-clay. Six and a-half miles above the mouth of the creek, the following section is exposed:—

	FEET.
Dark, superficial sandy clay	} 15
Light-yellowish stratified clay	
Hard dark-coloured columnar boulder-clay.....	35
Grey sandy clay-shale and light-grey sandstone.....	30
	80

Coal seam.

Half a mile further down the creek, a seam of coal is seen at the water's edge, overlain by ten feet of white clayey sandstone, and dipping slightly towards the west; and a short distance further east, the same seam is fully exposed above the water, showing a thickness of four feet six inches, underlain by eight feet of dark sandy shale, and overlain evenly for a considerable distance by the columnar boulder-clay. Specimens from this seam have been examined by Mr. Hoffmann, who describes it as a lignite of good quality, very similar to that cropping out on Knee Hills Creek, and described on p. 73 E of this report. From this point down, the sides of the valley are composed of the white clays, shales and sandstones of the Edmonton subdivision of the Laramie.

Surcee Butte.

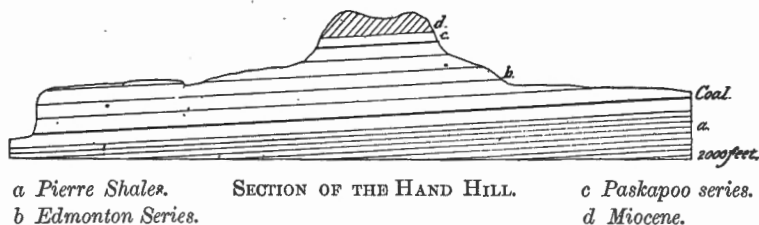
Surcee Butte, which lies five miles north of the mouth of this creek, is a rounded eminence rising about 300 feet above the level of the surrounding plain. Its sides are sloping and grassy, except towards the north where close to the summit there is an exposure of forty feet of light-grey clay-shale and light-yellowish clayey sandstone, including about the middle a band of dark shale with some hard sandstone containing impressions of ferns and exogens.

North of the headwaters of the streams just described, as well as around Quill Lake, the country is very rolling, with occasional wide flat stretches, no rock exposures being seen.

HAND HILLS.

Hand Hills.

These hills form a high table land, rising 1,000 feet above the general level of the surrounding prairie, and 1,350 feet above the level of Red Deer River to the south-west.



a Pierre Shales.

SECTION OF THE HAND HILL.

c Paskapoo series.

b Edmonton Series.

d Miocene.

They are called by the Crees, Michichi Ispatinan or Hand Hills, on account of their resemblance to the outstretched fingers of the hand, the top of the table land not being flat, but composed of five ridges

which radiate from a centre lying to the south-east. To the north-west, west, and southwest, they rise abruptly from the sloping plain in bold escarpments five hundred feet high, but to the east they slope gradually, interrupted here and there by rolling hills, to the valley of Bull Pound Creek, where they end in a steep, though grassy slope, extending down to the wide plain through which this creek winds. This latter slope is, however, cut by numerous coulées, along the sides of which excellent exposures of the white banded clays and sandstones of the Edmonton series may be seen.

On the western face of the Hills the following may be taken as a generalised section of the rocks exposed:—

	FEET.	INCHES.
Loose quartzite pebbles imbedded in a sandy calcareous matrix	15	0
Quartzite pebbles cemented into a hard conglomerate by calcareous cement	2	0
Loose mass of pebbles, sand and marl	10	0
Light-grey and yellowish, stratified, argillaceous marls, with some intercalated beds of fine-grained brown sands. In the upper beds some thin layers of limestone occur, which show on broken surfaces dendritic markings of oxide of manganese	270	0
Light-brown, false-bedded sandstones	100	0
Grey clay-shale	30	0
Lignite	3	6
Plastic clay	2	0
Lignite	4	6
Grey clay-shale and white clayey sandstone for several hundred feet .....	..	..
	437	0

In the lowest beds of this section, we have the typical rocks of the Edmonton subdivision of the Laramie. If we assume for these a south-westerly dip of fifteen feet to the mile, which is about what is indicated by a line drawn from the top of the whitish clay shale and sandstone in these hills to the corresponding beds in the Wintering Hills, we have here a thickness of seven hundred feet shown for this subdivision. Overlying this lower subdivision of the Laramie, a hundred feet of brownish sandstone of the Paskapoo subdivision crop out along the face of the escarpment, the rest of the upper portion of this series having there been eroded away. Lying immediately on the top of these brownish and lamellar sandstones, stratified argillaceous marls and sands extend upwards for two hundred and seventy feet, the beds being as far as can be seen, perfectly horizontal. This total thickness is not exposed in any one continuous section, the best

Edmonton series.

Paskapoo series

Miocene beds.

Quartzite
conglomerate.

exposures of the upper beds occurring in the highest of the western escarpments, where they are seen to run up into the overlying conglomerates. The lower beds, and the contact with the underlying sandstone, are visible only in some coulées on the south-west side of the hills leading down into Shell Creek. On some of the highest points of the hills, a bed of twenty-seven feet of quartzite gravel overlies the stratified marls, the matrix being a mixture of sand and lime, sometimes loose and sometimes cementing the mass into an exceedingly hard conglomerate. These conglomerates, with the underlying marls and sands, are so similar to the Miocene beds of the Cypress Hills, that I have very little hesitation, even in the absence of fossil remains, in classing them in that formation, although, as their material was doubtless brought down from the mountains to the west by a different stream, the deposition of the two may not have been exactly contemporaneous. The conglomerates in the upper part of this series being very much harder than the underlying sandstones and shales of the Laramie, offered a much greater resistance to the denuding agencies which wore down the surface of the surrounding country, thus preserving these hills as an elevated plateau rising 1,000 feet above the level of the adjoining prairie. They have, however, been themselves largely denuded, and the quartzite pebbles of the upper beds have been re-distributed over the greater portion of the hills lying on the eroded surface of the underlying marls, which in one place were observed to

Re-distributed
gravels.

have a thickness of not more than ten feet above the Laramie sandstone, the re-distributed gravels having a thickness of fourteen feet. Mr. McConnell found similar gravels along the south Saskatchewan, and around the base of the Cypress Hill, and as they underlie and are evidently older than the boulder-clay, he has classed them as Pliocene under the name South Saskatchewan group.* As this is a similar re-distribution of Miocene gravels, it seems probable that they are of the same age.

Bull Pound
Creek.

Immediately east of the Hand Hills, Bull Pound Creek runs southward into the Red Deer River. Forty miles above its mouth, the light-grey and whitish sandstones of the Edmonton series crop out on the sides of lateral valleys running in from the higher ground to the east. Lower down the wide, flat valley in which this small stream winds, exposures of similar whitish sandstone and sandy shale, with, in many places, numerous ironstone nodules and thin beds of lignite, occur on either side, having often a local dip of several degrees. In the most southerly of these exposures on the east side of the creek, a seam of lignite outcrops, four feet six inches of which were seen, but both the bottom and the top were covered by land-slides. Though the

* Geol. Survey Report for 1885, pp. 59, 70 c.

lignite was moderately compact, as far as seen, it was of poor quality and would be of little use as fuel, except for local supply. South of this point, the land gradually lowers for about three miles till it reaches the level of the plain to the south-east. On the west side of the creek, the country is roughly undulating and hummocky for twelve miles further south, forming a wide base round the foot of the Hand Hills in that direction. A mile below the crossing of the Lord Lorne trail, the creek enters a narrow valley, the sides being at first composed of sand and clay, but two miles and a-half further down, horizontal light-brown sandstones begin to appear, and shortly afterwards become interstratified with slate-coloured and light-brown sandy shale. Seven miles below the crossing of the Lorne trail, a small *Baculites*, together with fragments of *Lunatia concinna*, was found in the brown sandstone, showing that we had reached the marine shales and sandstones of the Fox Hill and Pierre group. Below this the valley becomes deeper and the sandstone gradually gives place to a dark clay shale, containing numerous crystals of selenite and ironstone nodules; eight miles above the mouth, where the banks are seventy-five feet high, *Lucina occidentalis* and *Baculites compressus* were collected in this dark clay shale.

Berry Creek is very similar in character to Bull Pound Creek, except that in its lower portion, it runs in a wide, open, grassy valley. Near the mouth of Dead Fish Creek, which is, however, eleven miles below the southern limit of the accompanying map, there is a low exposure of dark clay-shale with ironstone nodules. Fourteen miles further upstream, at the crossing of an old trail, forty feet of light-coloured sandstone interbedded with dark-grey shale, including beds and nodules of ironstone, were seen. In these sandstones and shales were found *Gervillia recta*, var. *borealis*, *Tancredia Americana* and *Placenticeras placenta*, var. *intercalare*, along with a fossil plant, described by Sir J. W. Dawson as *Abietites Tyrrellii*. North of this point, the creek, for sixteen miles, runs in a moderately straight valley, the sides of which, averaging about fifty feet in height, are composed mostly of the dark-coloured boulder-clay. For the next ten miles, the valley is crooked and sometimes ill-defined, a few exposures of boulder-clay and stratified sand containing boulders, occurring at the bends of the stream. At the junction of a small stream from the west, sixty feet of dark-coloured sandy shale containing crystals of selenite and spherical hollow nodules of ironstone, are exposed below the boulder-clay, and for six miles up this western branch, similar shales occasionally crop out. At this point, the dark shales are seen to be overlain by light-grey and yellowish sandy shales, which, a little further up, form low bad-land banks close to the creek, where a seam of lignite crops out two feet six

inches in thickness. For the rest of the course of this western branch, white sandstones are occasionally seen along its banks. On the main creek itself, four miles above the mouth of the last mentioned branch, are exposures of dark-grey iron-stained clay-shale containing crystals of selenite and spherical nodules of ironstone, on the top of which rests a layer of hard brown sandstone, and half a mile further up, under the dark boulder-clay, light-brown sandstone and grey clay-shale are seen in a low escarpment. Above this, the valley rapidly loses its definite character, and spreads out into a wide clay flat very similar to that on the Bull Pound east of the Hand Hills. Fourteen miles further north, the valley again contracts but becomes much more irregular, and eventually widens out again into the broad flats east of Sullivan Lake. A few exposures of light-grey clay-shale occur on these upper portions; and on the ridge to the west, in coulées and small areas of bad lands, the whitish clayey sandstones and sandy shale of the Laramie with numerous nodules of flinty ironstone, outcrop in sections, in some places, fifty feet high. Near the creek, numerous Laurentian erratics are scattered over the sloping sides of the valley.

Wide clay-flat.

Sullivan Lake. Sullivan Lake, the water of which is white from suspended clayey matter, has probably at one time been connected with the upper end of this creek, but is now quite cut off from it and without outlet. Around the southern main portion of the lake, the land is low, but it rises on the western and southern sides into rolling hills at a short distance from the shore. On both sides of the north-western arm, bad-land banks are seen at a distance of about half a mile back from the lake, a white mud flat stretching from their base to the water's edge. On the western side, where the rocks were more particularly examined, the scarped hill-sides showed the usual section of the lower part of the Laramie, white and grey clayey sandstones and sandy shales interstratified with beds of ironstone and lignite; one of these latter is four feet in thickness, but very shaly and of poor quality. In some places it has been extensively burnt and the red and yellow cinders have fallen down and covered the banks.

Blood Indian Creek.

Passing over the east branch of Berry Creek, Blood Indian Creek is the next stream flowing south into the Red Deer. Its banks, where we crossed it, were low and sloping, but in one place eight feet of typical dark grey Pierre shales, holding crystals of selenite, cropped out from under the overlying boulder-clay.

Sounding Creek

North of Blood Indian Creek, Sounding Creek flows eastward and then northward into Battle River. At the crossing of the Lord Lorne trail, its banks are ten feet high and are composed of boulder-clay overlying soft white sandstone, and four miles down the creek

under a layer of loose sand, ten feet of dark-grey Pierre shale is exposed. A mile and a half further down, there is a considerable local disturbance of the strata, two outcrops half a mile apart, showing soft yellow sandstone and dark clay shales dipping at angles of 70° and 50° respectively, though these are doubtless small local folds which do not bring up any considerable thickness of the underlying rocks. Three quarters of a mile below the last mentioned exposure, similarly disturbed, soft light-grey sandstones were met with, including bands of yellow nodular ironstone in which were found *Gervillia recta*, var. *borealis*, *Lunatia concinna* and a species of *Anchura*, and a mile and a half further east, about the centre of Range 8, there is a thirty-foot exposure of horizontal light-grey sandy shale filled with crystals of selenite and including a band of rounded nodules of ironstone. In and associated with these nodules a number of fossils were found, which, like those just mentioned, are characteristic of the Pierre, viz:—*Baculites grandis*, *Placenticeras placenta*, *Hydatina parvula* n. sp., *Linearia formosa*, *Pteria linguiformis*, *Protocardia subquadrata*, *Palæastacus ornatus*, n. sp., and a fin, centrum and spine of a fish.

Dark clay-shales begin to appear below these sandy beds, a little further down the stream, and for twenty miles, low exposures of these shales are all that is seen of the underlying rocks. Near the western limit of range 5, however, the valley becomes narrow, with bad-land sides a hundred and twenty feet high, showing the following section:

	FEET.
Covered	20
Grey sandy shale with bands of nodular yellow ironstone.	20
Fine grey clay.....	10
Slate-grey clay-shale.....	50
Covered.....	20
	<hr/> 120

These beds are practically horizontal and are exposed almost continuously for about five miles, where the valley again becomes wide and sloping. The face of the bare white bank is in many places scattered over with numerous crystals of selenite, and one third of a mile below the above section, in a band of yellow ironstone, twenty-five feet from the bottom of the bank, fragments of *Placenticeras placenta* and a species of *Ostrea* were collected.

At its northern bend, the valley is very wide, with an extended interval of adhesive impervious clay, and it is not till four miles north of the bend, that low exposures of grey clay shale again appear and extend for seven miles along the sides of the valley. The shales

Anticlinal fold.

Belly River series.

here as before, contain numbers of crystals of selenite and are mixed with beds of clayey sandstone. For the next twenty-three miles, the valley is very wide, the creek expanding in one place into shallow "alkaline" lakes. Five miles to the east of these lakes, in township 33, range 4, a ridge rises by a gentle slope from the west, while on the eastern side it is washed out into two deep amphitheatre-like hollows. The sides of these hollows are about one hundred and forty feet high, and are composed of light-grey clayey sandstone and clay-shale with bands of light brown lignite, and, especially towards the bottom, bands of almost black nodular ironstone, while the shales in places contain a few crystals of selenite. These rocks lie on an anticlinal striking N. 85° E., evidently a local crumpling, which brings up the white beds of the Belly River series from beneath the shales of the Pierre. It was impossible to determine exactly the thickness of the beds here brought to the surface, but in one place, for a length of twelve hundred feet, they were found to dip N. 5° W. at an angle of 30°, which implies a thickness for the beds here exposed of six hundred feet, and neither the top nor bottom of the formation was seen in this section. This heavy dip of the strata in the centre of the surrounding flat-lying beds of the plains is very remarkable; a similar phenomenon was noticed by Dr. G. M. Dawson, on the Milk River, close to the international boundary, where beds of this Belly River series of the same age as those here seen are brought to the surface over a small area.*

Neutral Hills.

The next exposure seen while following the creek northward was on the east side of the valley in township 35, five miles above Sounding Lake, where ash-grey clay and clayey sandstone crop out in a number of small exposures extending for fifty feet up the side of the hill, representing some of the higher beds of the Belly River series. For the rest of the distance to Sounding Lake, the banks, though high, are grass-covered and rarely show any signs of the underlying rocks.

The Neutral Hills are an irregular plateau rising gradually from the plains to the south to a height of five hundred and thirty-five feet above the surrounding country, and, especially in their north-western part, are cut through, by several deep depressions. The rolling, partly wooded hills to the north are composed of a pure or clayey sand washed down from the face of the higher plateau to the south, while the main ridge to the south is largely composed of the shales and sandstones of the Pierre, the sandstones being the most conspicuous, projecting as ledges from the sides of the hills. The best section is seen at the "Nose," where soft, brownish and light-grey clay-shales are exposed, containing nodules of ironstone, and having a vertical thick-

* See *Geology and Resources of the 49th Parallel*, p. 114.

ness of six hundred feet. In the upper part of this section, the shales contain large numbers of crystals of selenite, along with specimens of *Protocardia borealis* and *Baculites compressus*. At the bottom of the section, which is seen on Ribstone Creek, a small stream flowing northward immediately west of the "Nose," the rocks consist of dark-grey clay-shale associated with beds of brownish-yellow, friable sandstone, in which were found *Placenticerias placenta*, *Baculites compressus* and *Liopistha undata*. In the more easterly parts of the hills, the lowest beds are composed of the whitish sandy clays of the Belly River series.

These hills lie on the western side of the low anticlinal which stretches northward from the South Saskatchewan River, bringing to the surface the sandstones of the Belly River series, which has been preserved as hills by their capping of Pierre shales; which, though soft, offer more resistance to the denuding agencies than the sandstones above and below them. The tops and sides of the hills are scattered over with pebbles of chert and boulders of gneiss and limestone, often in great numbers.

BATTLE RIVER AND ITS TRIBUTARIES.

On or just west of the 114th meridian, a stream flows from Pigeon Lake and one from Battle Lake, which, after courses of eleven miles each, join to form Battle River.

Pigeon Lake, the largest and most northerly of the two lakes, is eleven miles long and four to five miles wide. It is surrounded, except on the south-east side, by thickly wooded hills which rise from one to three hundred feet above the water. The sides and summits of these hills are strewn with gneissoid boulders, which also cover the shore of the lake, though at low water in some places a sandy beach stretches for a few yards between the edge of the water and the boulders.

Battle Lake is much smaller, being only four and a-half miles long and half a mile wide, though it is reported to be very deep. It simply occupies the bottom of the old valley down which Battle River flows eastward; towards the west the bottom of this valley is occupied by an impassable morass. The south shore is four hundred feet high, and thickly wooded, while to the north the country is much lower and more open. At the west end of the lake there is a hill three hundred and ten feet high, the sides of which are scarped in numerous places, showing the following section which is very typical of the Paskapoo series:—

	FEET.
Paskapoo beds.	
Covered, the outer soil being sandy	70
Olive sandy shale containing towards the top concretionary nodules of grey limestone.....	30
Covered	50
Bands of rather hard yellow sandstone cropping out through the sod.....	30
Light-grey shaly sandstone.....	15
Light-yellowish or greenish-grey, rather soft, thick-bedded sandstone, false-bedded in places, weathering with rounded face, and towards the bottom mixed with some bands of sandy shale.....	60
Covered	40
Light-grey, lamellar, rather fine-grained sandstone.....	5
Covered	10
	<hr/> 310

Between Battle Lake and the mouth of Pigeon Creek, the bottom of the valley is very swampy, and small springs flow out of the bank, which is composed of the grey sandstone and shale of the Paskapoo subdivision of the Laramie.

Between the mouth of Pigeon Creek and that of Wolf Creek, the valley is open, with sloping sides, which but rarely show any indications of the character of the underlying rocks, but, where there are exposures, they are seen to be horizontal sandstones and shales of the Paskapoo series, similar to those occurring both higher up and lower down-stream.

Wolf Creek.

Wolf Creek is a small stream flowing in from the south, fifteen feet wide and a foot deep, with (except near its mouth) low grassy banks, showing nothing of particular geological interest. From the mouth of Wolf Creek to the "Leavings," the banks of the Battle River are low and overhung with willows, being composed of alluvial sand and clay. A mile below the "Leavings," on the Edmonton Trail, a bed of quartzite gravel, two feet thick, similar to that seen on the Red Deer near the mouth of the Blind Man, crops out on the north bank, a little above the water. Three miles further east, low banks of dark-coloured boulder clay are seen, overlain by twenty feet of stratified sand, in which false-bedding is excellently shown. The southern shore of Battle River Lake was not examined, but in crossing it and skirting for a short distance along its north-east side, no rock was seen in place, though its margin was found to be composed of a great number of gneissoid boulders, and on the west side, where the land is low and marshy, lumps of coal of considerable size are reported to have been picked up. North of Battle River Lake no exposures are met with till the river turns to the east, low escarpments of both the lower and the

Battle River Lake.

upper boulder-clay occur then at intervals along both sides of the stream. At the bend to the north, the banks become much higher, but for several miles are still composed of boulder-clay, underlain by a bed of quartzite pebbles. Six miles north of the last mentioned bend, the underlying Laramie rocks are seen for the first time as sandstones and olive sandy shales of the Paskapoo series, rising eight feet above the level of the water, which is here at an elevation of 2,450 feet. For the next three miles grey sandstone and sandy shale form the lower part of the bank, while the upper part is composed of the pebble bed overlain by light-coloured stratified boulder-clay. In one place, the bank shows thirty feet of sandstone and sandy shale, with a seam of coal five inches thick towards the top. In a depression Pebble bed. in the upper bed of sandstone, probably the section of an ancient channel of a small stream, there are collected a great many large boulders, most of which are of quartzite, but some few are of gneiss, with numerous pebbles of ironstone. This pocket, along with the surrounding sandstones, is evenly overlain by a bed twelve feet thick of quartzite pebbles. Just below the mouth of Pipestone Creek, white Pipestone Creek. clayey sandstone, with reddish bands of ironstone, belonging to the Edmonton subdivision of the Laramie, were first seen. At the water's edge a seam of coal crops out. Two miles up the Pipestone, the beach is still composed of similar sandstone and of whitish sandy shales in which fragments of Dinosaurian teeth and bones and silicified wood were found. Still further up on this stream, where the Bigstone joins it from the south, the light-coloured clays and sandstones are seen to be gradually overlain by the olive sandy shale and brownish-yellow sandstones of the Paskapoo series, these latter sandstones often containing large nodules of limestone, which would, doubtless, burn into a very good lime. The coal seam outcropping on the Red Probable coal horizon. Deer and Saskatchewan rivers, at the bottom of the Paskapoo series, was not seen here, and it is possible that it has thinned out locally, but it is more probable that its outcrop is silted over with white clay, or overgrown with grass or brush, and that, on closer examination, it will be found in this vicinity as well as both to the south and north. Above the mouth of Bigstone Creek, the valley is shallow, with sloping sides, and very few exposures are seen except of boulder-clay. The exposures that do occur consist of light-grey and yellow soft sandstone and sandy shale, which may belong either to the top of the Edmonton, or to the bottom of the Paskapoo series.

On Bigstone Creek, close to its mouth, the following section of Bigstone Creek-Paskapoo beds is exposed:—

	FEET. INCHES.	
Soft yellowish-grey sandstone.....	6	0
Olive sandy shale with friable nodules of ironstone.	8	0
Olive and grey jointed sandstone.....	6	0
Band of hard, compact sandstone.....	0	6
Friable masses of ironstone mixed with olive shale..	0	6
Grey and olive sandy shale and soft sandstone....	12	0
Covered.....	5	0
Hard, grey, compact, calcareous sandstone, breaking off in large angular blocks.....	4	0
	<hr/>	
	42	0

A mile further up this creek, the valley is very narrow and a hundred feet deep, exposing eighty feet of grey and olive soft sandstone and of olive sandy shale containing thin bands and nodules of ironstone, and towards the top, beds of harder sandstone. Along the creek up to its source in Bear Lake, exposures of the underlying rocks are very rare, and the shores of the lake itself are low and swampy.

Peace Hills.

In the Peace Hills, some very good sections of the superficial deposits are seen. In one case, the side of a knoll has been washed away, exposing thirty feet of horizontally bedded light-yellow sandy boulder-clay, containing pebbles and boulders of quartzite and gneiss, representing the upper boulder-clay, which has been laid down in greater thickness than usual, and afterwards partly eroded away, leaving the Peace Hills, as they now are, a mass of irregular hills and broken ridges.

Battle River below Pipe- stone Creek.

Below the mouth of Pipestone Creek, the sides of the valley of Battle River are mostly sloping, grassy on the north side, but the south side is wooded with poplar and occasional groves of birch and spruce. Scarped banks of whitish sandstone and shale streaked with thin beds of lignite and clay ironstone are also occasionally seen, the whole overlain by a bed of quartzite pebbles.

Dried Meat Lake.

Five and a half miles below Battle River Settlement, the river flows into Dried Meat Lake, having first skirted along its northern edge for a mile and a half. This lake is an expansion of the river which spreads from side to side in the bottom of the valley, here from one hundred and fifty to three hundred feet below the plain. The north-east side of the valley is occupied by open poplar bush, while to the south-west the poplar is much thicker, and spruce is also occasionally seen. Where the rock is exposed, it is white clayey sandstone and sandy shale, with thin beds of ironstone. Above the south end of the lake, the following section was measured:—

	FEET.	INCHES.
Concealed	100	0
White sandstone	35	0
Carbonaceous shale	0	9½
<i>Lignite</i>	1	9
Lignitic shale	0	11
White sandstone and shale	70	0
	208	5½

Low escarpments of the white sandstone of the Edmonton series occur at intervals close to the bend of the stream, and twelve miles below the southern end of the lake, a seam of coal crops out at the Coal seam. water's edge, two feet ten inches thick, overlain by sixteen inches of brown lignitic shale, under fifteen feet of white clayey sandstone. The coal seam runs along close to the edge of the water for a short distance. Six miles further down the river, the following section is seen :—

	FEET.	INCHES.
Whitish clayey sandstone	60	0
Two thin seams of <i>lignite</i> separated by eighteen inches of shale	2	0
Whitish sandy shale	14	0
<i>Coal</i>	3	4
Clayey sandstone and sandy shale	120	0
	199	4

From here to the mouth of Meeting Creek, a distance of eight miles, Battle river winds in a valley a mile wide and two hundred feet deep, the west side being mostly timbered, the east side either grassy slopes or bare banks of sandy clay reddened by the cinders that have been washed down from the burnt coal above. These red cinders also form layers in the bottom of the valley, interstratified with the alluvial sand and clay to a depth of twenty feet, and buffalo bones are found in the alluvium to a depth of fifteen feet.

Meeting Creek has its source in some small lakes west of Todd's Meeting Creek. crossing of the Battle River, and flows south of east to join the latter stream. In its banks, composed of white clays and sandstones, the following section is shown, two miles above its mouth :—

	FEET.	INCHES.
Whitish clayey sandstones and sandy shales, the above portion containing many ironstone nodules and large masses of ferruginous sandstone of a bright-yellow or red colour.....	50	0
Carbonaceous shale.....	0	8
Coal, compact	4	6
Fine dark clay-shale.....	9	0
Whitish sandstone.....	50	0
	<hr/> 114	<hr/> 2

A proximate analysis of this coal, by Mr Hoffmann, gave:—

Hygroscopic water.....	11.68
Volatile combustible matter.....	35.82
Fixed carbon.....	49.88
Ash.....	2.62
	<hr/> 100.00

The general character of the seam is very similar to that cropping out on Knee Hills Creek, which is described on page 73 E.

A mile and a half further up the valley, the same seam is seen exposed eight feet above the water, and allowing the creek a fall of ten feet in that distance, which is probably more than it actually has, the beds would have a dip up-stream of twenty-seven feet to the mile, and drawing a straight line from this point to "the Maples" on Battle River, the place where this seam first crops out, and which is on about the same level, the strike of the beds is shown to be N. 20° W. For ten miles further up Meeting Creek, similar sandstones and shales are exposed, forming high "bad-land" banks; then the valley becomes much shallower, and the sides more sloping and grassy.

Battle River
below Meeting
Creek.

Below the mouth of Meeting Creek, for fifteen miles, the valley of Battle River continues well defined and about two hundred to two hundred and fifty feet deep, similar whitish sandstones being exposed at intervals all along the banks. In one place, eleven miles from Meeting Creek, the coal seam is well exposed one hundred and eighty feet above the water, showing the following section:—

	FEET.	INCHES.
Black and brown shale.....	0	3
Coal	0	6
Shale and clay.....	0	3
Coal	4	6
Shale.....	1	0
Coal	0	9
	<hr/> 7	<hr/> 3

Underlain by soft white sandstone and overlain by grey clay-shale.

Four miles further on, the following section is exposed:—

	FEET.
Seam of burnt coal. ....	..
White sandstone.....	30
Brownish banded sandy shale ..	50
Covered.....	30
Dark sandy shale.....	50
White nodular sandstone, at water's edge.....	..
	<hr/> 160

A mile and a half further down the valley, in one of the ferruginous nodules in this latter layer, *Placenticeras placenta* was found, and the bottom of the bed, which is ten feet thick, is a broken mass of shells of an *Ostrea*, mingled with *Cyprina ovata* and thick calcareous tubes, possibly of *Teredo*. This is the highest bed that can be definitely determined as belonging to the Fox Hill and Pierre group, and as shown in the last section, it lies one hundred and sixty feet below the coal seam which is seen cropping out on the sides of the valley for twenty-five miles. This is the exact thickness given by Mr. McConnell* for the beds between the coal seam and the top of the Fox Hill and Pierre group on the Red Deer River, and there is little doubt but that it is a continuation of the latter seam, which he identified with the seam cropping out at Blackfoot Crossing on the Bow River.

Associated with the bed of fossiliferous sandstone, is a thin bed of limestone in which excellent examples of "cone-in-cone" structure are seen. This is close to the mouth of Paint Earth Creek, and here the valley is very wide, steep escarpments of white clayey sandstone being seen about two miles to the south of the river. From the mouth of Paint Earth Creek to the Elbow, a distance of twenty miles, the sides of the valley are sloping and grassy, or wooded with balsam poplar, and some spruce. A few low exposures of greyish-green and brownish sandy shale and nodular sandstones occur at the bends of the stream, though near the Elbow these are underlain by dark-grey clay-shale. Twelve miles above the Elbow, at the foot of one of the steeper banks, the following fossils were found in the brownish sandstone, viz.:—

Placenticeras placenta, *Ostrea subtrigonalis*, a very large *Ostrea*, somewhat like *O. glabra* but possibly new, *Solecuretus occidentalis*, n. sp., and *Cyprina ovata*. Two miles above the Elbow a small stream flows in from the south-west, and at its mouth a rounded butte rises about two hundred and thirty feet above the level of the flat exposing the following section:—

Pierre fossils.

*Geol. Survey Report for 1882-4, p. 95 c.

	FEET.
Light grey soft sandstone with included lenticular concretions of ironstone, in which are found fragments of <i>Platoniceras placenta</i> , and in the same beds <i>Protocardia borealis</i> was also found.....	130
Covered	20
Dark crumbling clay-shale.....	50
Covered.....	20
	220

Pierre fossils.

Along the lower part of this stream the banks for five miles are very steep, two hundred feet high and considerably covered with spruce. They are seen to be composed of dark clay-shale, underlain by brownish sandstone containing nodular masses of ironstone along with well preserved specimens of *Protocardia subquadrata*, *Liopistha undata*, *Panopæa subovalis*, burrows of a species of *Teredo* or *Turnus*, and *Baculites compressus*. Above this the banks become sloping and grassy for several miles, and then the white-banded sandstones of the bottom of the Lar- amie appear in a mass of naked cliffs at the top of a slope towards the north. On the banks of a southern branch of this stream, numerous exposures of boulder-clay were seen overlying the dark clay-shale. The stream is blocked by a great number of beaver dams, many of them newly built.

Elbow of Battle River.

At the Elbow, a small stream joins the river from the south. The banks are three hundred feet high, the upper twelve feet being the upper light-coloured boulder-clay, underlain by forty feet of grey shale and ten feet of yellowish soft sandstone. The rest of the bank, with the exception of a bed of dark clay-shale at the bottom, is covered with land-slides.

Belly River series.

From the Elbow the river turns and runs north-eastward for sixty-three miles to the mouth of Grizzly Bear Coulee. In the first two or three miles of this distance, low outcrops of dark-grey shale occur, and four miles below the Elbow there is an exposure, from the edge of the river up, of thirty feet of light-grey sandstone, representing the top beds of the Belly River series, overlain by the dark-grey Pierre shales. This bed of light-grey sandstone, often including bands of sandy ironstone, is seen to rise gradually in the sides of the valley as the river is descended. The sides of the valley are abrupt and steep up to the top of the sandstone, but above it they slope up gradually to the level of the prairie, which is two hundred and fifty to three hundred feet above the river. These banks are very similar to those of the Red Deer River near Hunter's Hill, where the Pierre shales are seen to occupy the surface of the country, which gradually slopes down to the brim of the Red Deer valley, and the valley is then cut down

several hundred feet through the white sands and clays of the Belly River series.

For fifteen miles above the mouth of Iron Creek the valley is wide and open, with sloping grassy sides, in which, however, a few low exposures of white and yellow sandstone crop out close to the edge of the water, while back from the river the flats are occupied by hillocks of loose yellow sand, thirty to fifty feet high. At the mouth of Iron Creek the flat is underlain by a bed, six feet or more in thickness, of coarse gravel. The Iron Creek valley for six miles upward from Battle River is very wide, and full of sandy hills, while for eleven miles further it is well defined and a hundred feet deep. In the sides in this distance no exposures of the underlying rocks occur, but in most places yellow unstratified sand appears to cover them from top to bottom, except for the last two or three miles, where as much as twenty-five feet of sandy clay containing pebbles of quartzite and gneiss, are seen at the edge of the creek, representing in all probability the lower boulder-clay.

Sandy hillocks.

Iron Creek.

Light-grey sandstone.

Near the crossing of the old trail from Victoria to the plains to the south, twenty feet of light-grey and yellowish, somewhat clayey, soft sandstone and grey sandy clay-shale including beds of brown ironstone, are seen in the side of the valley, at an elevation of 2,090 feet above the sea. For six miles further up the creek, horizontal, soft, whitish or light-grey sandstone with yellow iron-stained beds and bands of laminated ferruginous sandstone and numerous nodules of yellow ironstone, crop out to a height of ninety feet above the bottom of the valley. In one place a large number of fragments of fresh-water fossils, such as *Unio*, *Sphaerium* and a gasteropod like *Campeloma producta* were collected from the ironstone nodules. These sandstones and clays represent the upper part of the Belly River series, and lie on the western side of the wide anticlinal which brings this formation to the surface. Along the creek up to its source in Wavy Lake, at an elevation of 2,260 feet, a distance of twenty miles, the country is undulating and the soil is sandy, but no trace of the underlying rocks is to be seen, though on the ridge west of Wavy Lake a dark clay washes from the side of the hill, very like the clay derived from the degradation of the Pierre shales.

Meteoric iron.

It was close to this creek that the mass of meteoric iron now in the museum of Victoria College, Cobourg, was found by the late Rev. George McDougall.*

The Battle River valley for five miles below Iron Creek is very wide and often dotted with sandy knolls, one of which was found to be one hundred and fifty feet high, and composed of

* See note by Dr. A. P. Coleman in Trans. Royal Soc. Can., 1886, Sec. III., p. 97.

loose yellow sand scattered over with pebbles of quartzite and gneiss, among which a few rose-bushes and trailing junipers manage to live. Thence to the mouth of Grattan Creek, a distance of nine miles, low outcrops of horizontally bedded light-grey and yellowish, rather soft sandstone interbedded with hard ferruginous sandstone, appear at intervals, close to the edge of the water. But much better sections of these sandstones of the Belly River series are to be seen in Grattan Coulée. In this valley, three miles above the mouth of the creek, the following section was obtained on the south bank:—

Grattan Creek.

	FEET.
Loose sand containing towards the top a large number of boulders of gneiss and a few of quartzite	25
Soft yellow sandstone, with a layer of yellow ironstone and some harder sandstone containing fragments of silicified wood.....	10
Yellowish soft sandstone, with a three-inch bed of broken lignite associated with a layer of soft plastic clay. Scattered through the sandstone are many brown, dark-weathering nodules of ironstone.....	40
Rather clayey, yellowish-white, soft sandstone.....	20
Covered (down to the water).....	75
	<hr/> 170

Up the same valley for a distance of eighteen miles bad-land banks of soft whitish and yellowish clayey sandstone, to a height in many places of a hundred feet, form its sides till the level of the prairie is reached, at an altitude of 2,210 feet above the sea. No fossil remains have been found in these beds, except a few broken fragments of bone and silicified wood, but there can be no doubt that their position is near the top of the broad anticlinal which runs northward past the Neutral Hills and below the Pierre shales. They present the characters of both the white and yellow subdivisions of the Belly River series, though the white sandstones here underlie the yellow, and, further east, either change their character and become less clayey, or disappear under the overlying yellow beds, though these latter do not immediately underlie the Pierre on the western side of the anticlinal.

On Battle River, between the mouths of Grattan and Buffalo creeks, the valley is narrower than usual and much more thickly wooded, only two or three exposures of hard yellow sandstone being seen on its sides. A mile above Buffalo Creek, however, the following section was seen:—

	FEET.
Shaly sandstone.....	3
Light-coloured brownish yellow sandstone with nodular layers of calcareous clay ironstone containing traces of fossil leaves.....	7
Ferruginous sandstone breaking, when struck, into small, irregular fragments.....	3
Soft grey shaly sandstone.....	7
	<hr/> 20

Turning up Buffalo Coulee, the banks for the first eighteen miles are composed of greyish-yellow soft sandstone with bands of yellow ferruginous sandstone. Further up, where the creek expands into a small lake, a seam of lignite ten inches thick crops out underlain by six inches of brown lignitic shale between beds of soft, thick-bedded, whitish-yellow sandstone. This seam represents all the coal at present known to occur in the Belly River series in this vicinity. Further up the coulee some small exposures of soft and hard yellow sandstone are seen near the crossing of the telegraph trail, very similar in character to those already described. Buffalo Coulee.

From the mouth of Buffalo Creek for twelve miles north-eastward to the mouth of Grizzly Bear Creek, the Battle River valley is more open than in the previous stretch. The sides are from two to three hundred feet high, but are generally grassy, and very few small croppings of yellowish sandstone reveal the character of the underlying rocks. In Grizzly Bear Coulee from its mouth upwards, rocks distinctly characteristic of the Pierre are met with, dark-grey crumbling clay shales holding numerous crystals of selenite and rounded nodules of ironstone, while three miles above the mouth of the coulee, in a small branch coulee and at a height of two hundred and twenty feet above Battle River, a fragment of a *Baculites* was collected from these dark shales. Grizzly Bear Coulee.

For fourteen miles below the mouth of Grizzly Bear Coulee, as far as the last easterly bend of the river within the district, yellow, often lamellar sandstone with intercalated bands of ferruginous sandstone, may be seen cropping out in low exposures close to the water's edge. At the above mentioned bend, hard brown sandstone appears just below high-water mark, and blocks of similar sandstone are scattered along the edge of the stream. This sandstone, though overlain by a considerable thickness of Pierre shale, is essentially similar to the sandstone of the Fox Hill group, and contains the following species of fossils:—*Cyprina subtrapeziformis*, n. sp., *Modiola*, sp., *Pteria linguiformis*, var. *subgibbosa*, *Tancredia Americana*, fragment of an *Anisomyon centrale*?, *Astarte*, sp., *Ostrea glabra*?, *Lunatia concinna*, and burrows of *Teredo* or *Turnus*. Four miles east of the bend, sixteen feet Hard brown sandstone.

of light-yellowish sandstone is exposed above the water, overlain by dark-grey clay shale containing fragments of shells of *Gervillia*, while seven miles further east there is, close to the water, a low exposure of sandstone similar to the last, over which are fifteen feet of dark clay-shale holding shells of *Baculites*, and above for eighty feet up the bank, slides of similar shales are seen. Five miles further, or two miles above the mouth of Ribstone Creek, these dark Pierre shales come down to the water's edge, and from there to the crossing they form the sides of the valley from top to bottom.

Ribstone Creek.

We shall now turn to examine Ribstone Creek, which flows into Battle River from the south, three and a-half miles west of the crossing of the Fort Pitt trail. The valley for the first three miles is wooded, and the rocks are everywhere covered with earth-slides. Then in the bottom of the valley which is one hundred and sixty feet deep, there are exposed sixty feet of horizontal, yellowish, rather hard, false-bedded sandstone containing ironstone in beds and irregular nodules. This layer of coarse grained yellow sandstone continues up the creek for three miles till it disappears under the bed of the stream, which rises sixty-five feet in the same distance; but northward it probably changes into a sandy shale, as there is no trace of such a bed of compact sandstone to be seen in the valley of Battle River. Half a mile above where the sandstone is last seen in the bottom of the valley, there is a cut bank, thirty feet high, showing at the top yellowish-grey sandy shale, which is underlain by dark-grey clay-shale holding ironstone nodules in which *Inoceramus Sagensis* was found. From this point, for fifty-five miles up the creek, or thirty-four miles in a straight line S. 47° W., the valley is at times very wide, with marshy flats, and at times the sides are much more abrupt, but nowhere are the underlying rocks to be seen, the country being covered with a thick deposit of loose yellow sand, which is either piled up in irregular shifting knolls, or in long ridges lying more or less north and south. It is possible, however, that these ridges or higher points of the country, have a core of the underlying rocks which, in all probability, is composed of easily disintegrated, yellow sandstone, from which the surrounding sand has been in whole or in part derived, but whether in that case the sandstone would lie at the bottom of the Pierre, or belong to the yellow part of the Belly River series, it is impossible to say. At the point which we have reached, there is a hill on the east side of the valley which shows a section of fifty feet of light-grey, soft, clayey sandstone, with many yellow bands, and with seams of nodular black-weathering ironstone belonging, undoubtedly, to the Belly River series. Twenty-four miles east of this, on the trail from Fort Pitt to Sounding Lake, there are some low exposures of

Hard yellow sandstone.

Sandy knolls and ridges.

Sandstones of Belly River series.

similar sandstone and ironstone belonging to the same horizon. Following the creek for four miles further, we come to another exposure of twelve feet of similar light-grey soft sandstone including beds of brown nodular ironstone, overlain by light-grey plastic clay-shale. South of the hill in which this section occurs, the creek flows northward for several miles between sandy banks which rise gradually for some distance on either side into considerable ranges of hills. To the south of the most westerly of these ranges, the creek has worn out a wide valley, leaving the southern faces of the hills often scarped and bare, but unfortunately too much obscured by land-slides to allow of the satisfactory tracing out of the different beds without very great difficulty and expenditure of time. These hills are very hummocky, and are in many places covered with pebbles and large boulders of quartzite and gneiss. As the rocks, where seen, were dipping in different directions and at various angles, there can be little doubt that these rough hills have been formed by masses breaking from the face of the higher table land—which now remains as a slightly elevated central axis—and sliding over some of their constituent beds of soft unctuous clay down to the lower-lying country, where they rest as irregular knolls and hummocks that soon become rounded off by atmospheric erosion. The rocks are, like those last seen, light-grey clayey sandstones holding in one place a thin seam of lignite, and containing throughout nodules of black-weathering ironstone, in which are often included traces of woody fibre and pieces of beautifully silicified wood. In one place a layer of small pebbles was also seen, accompanied by a boulder of gneiss fifteen inches across and five inches thick. This sandstone is overlain throughout by a layer of dark-grey Pierre shale containing numerous crystals of selenite. The covering of shale prevents the hills from being worn down by atmospheric erosion as fast as the more sandy parts of the surrounding country.

The valley, however, is wide, with clay-flats stretching along either side of the creek, as far as the point where it cuts through the ridge which runs northward from the "Nose." Here there is an exposure of eight feet of light-brown soft sandstone, underlain by twenty-five feet of dark-grey clay-shale including nodules of brown ironstone, holding *Placenticerus placenta*, *Baculites compressus* and *Liopistha undata*. This is the same section mentioned on p. 82 E, in the description of the Neutral Hills, as being at least six hundred feet below the top of the Pierre, and as about three-quarters of a mile further east these shales are seen to rest on whitish clayey sandstones, we have here, doubtless; the bottom of the Pierre and the top of the Belly River series.

The last tributary of Battle River included in the area of the accompanying map, is Blackfoot Creek, which rises to the north-east of the

Junction of
Pierre and
Belly River
beds.

Blackfoot
Creek.

Blackfoot Hills, and, after a course of thirty-five miles, flows into Battle River just below the crossing of the Fort Pitt trail. In this valley, which is very deep towards its mouth but gradually flattens out towards the north up to the marshy lakes of which it is the outlet, only a very few exposures of the underlying rocks are seen, and these are dark-grey clay-shales with ironstones nodules, quite typical of the Pierre. The shales are overlain by a sandy clay or sand, and the hills are covered with gneissoid boulders.

COUNTRY LYING BETWEEN THE NORTH SASKATCHEWAN AND BATTLE RIVERS.

In this district, the exposures of the underlying rocks are very few; even where they do occur, they are slight and indefinite in character, and to all appearance, the bedding is perfectly horizontal. Fossils, too, even in beds such as the typical shales of the Pierre in which, a little further south, they are found in such profusion, are here almost entirely wanting, so that we can only assume that we are in the main correct in our determination of the position of the beds, and that the boundary lines of the formations, as laid down on the map, are approximately accurate.

White Mud
Creek.

Beaver Hills.

Towards the west, croppings of light-grey clays and sandstones with included nodules of ironstone of the Edmonton subdivision of the Laramie are found on White Mud and Black Mud creeks, and a coal seam also appears a mile and a-half below the trail crossing of Black Mud Creek. From here eastward, no rocks were seen in place till Beaver Creek was reached, the intervening country being occupied by the "Beaver Hills," with their low marshy tracts and lakes. These hills have already been described on p. 43 E of this report; we shall only add that they are composed entirely of superficial deposits of sand and sandy clay mixed with gravel, though it is probable that these deposits are laid down on a slightly elevated ridge of Laramie sandstone. Wherever sections of the drift were seen, as on Hastings' and Katchemut's creeks, it consisted of horizontally-bedded, hard grey sandy clay, containing numerous quartzite pebbles, though on their surface the knolls and ridges are covered with a slightly sandy clay derived, no doubt, from the wearing down, and perhaps redistribution, of the underlying drift. On the east side of the hills, however, there are some patches of white clay covered in places with a saline efflorescence, indicating the presence in the immediate vicinity of the white clays of the Edmonton series. On the east side of township 48, range 18, indications of coal, doubtless of Laramie age, are seen just south of the

telegraph trail, and on Beaver Creek, eight miles above where it flows into Beaver Lake, in section 5, township 50, range 18, there is an exposure, of the same age, of eight feet of whitish clayey sandstone, interstratified with beds of light-grey clay-shale and a bed of yellow sandy ironstone. Six miles further down the same creek, another low exposure of similar rock occurs.

Beaver Lake has low-lying shores, which show no signs of bedded Beaver Lake. rock; the beach consists of coarse grey sand, behind which is a pile of large boulders of gneiss and quartzite, which are constantly shoved back by the expansion of the ice in the winter and by its force when the water dashes it against them in the spring. On Beaver Creek, where it flows out of the north end of Beaver Lake, the banks are low and generally grassy for nine miles, then at a sharp bend in the stream, soft light-grey shale appears close to the water, and from this point to the crossing of the Victoria trail, horizontally-bedded, light-grey clayey sandstone and clay-shale with irregular nodules of calcareous ironstone and some bands of yellow ferruginous sandstone, crop out in low exposures along the channel of the creek. Near the trail crossing, there is a bed of bluish-grey friable clay-shale holding large lenticular masses of ferruginous sandstone and fragments of coal, the latter, not in any connected bed, but consisting of the carbonised trunks of small trees lying separately. This dark clay-shale soon changes, however, to a rather light-grey, sandy clay-shale including a nine-inch seam of coaly shale. Light grey clayey sandstone. For the rest of the distance to its mouth, the creek flows through swamp and thick scrubby forest, its banks being low, showing, for half a mile, light-grey sandstone and shale, and below that, light-coloured boulder-clay, or fine-grained bedded silt.

The whitish sandstones and clays seen along this creek belong, Laramie sandstone. undoubtedly, to the Edmonton subdivision of the Laramie, and though the shales at the crossing look much more like Pierre than Laramie, still the stratigraphy appears to connect them rather with the latter, and in the absence of all traces of fossils, it is not deemed advisable on such slight evidence to record the Pierre as occurring here.

About eighteen miles east of Beaver Lake is Vermilion River, Vermilion River. which rises near the old location of the Canadian Pacific railroad at an elevation of about 2240 feet. Flowing at first northward in a slight depression in the plain, it soon develops a definite channel, the sides of which show light-coloured, bedded sandy clay containing a few pebbles. In the north-western corner of township 49, range 15, the underlying rock first appears in a low exposure of dark-grey clay-shale containing minute crystals of selenite, while a short distance further down the creek, light-grey, similar clay-shales are seen, including large irregular brown-weathering nodules of calcareous

Pierre shales.

ironstone, sometimes vesicular and holding numerous impressions of plant fragments. For about eight miles down the river, this clay-shale with ironstone, which, no doubt, represents the lower part of the Pierre shales, crops out in the banks at short intervals, and then, for six miles, the banks are grassy or show only small sections of superficial sand or clay.

Belly River series.

About the centre of township 52, range 14, clay-shale again crops out, associated with beds of ash-grey lamellar sandstone, and including nodules of calcareous ironstone, containing impressions of leaves, among which were *Podocarpites*, *Tyrrellii* and *Trapa borealis*. The latter species has, up to the present, been found chiefly in beds of the Edmonton series, but Sir J. W. Dawson states, with regard to it, that it "is associated, at several localities, with *Pistia* and *Lemna*, and in this respect, the beds holding it conform in their flora to the Belly River series on the South Saskatchewan." In the present instance, considering what we know of the surrounding strata, it is highly probable that the beds here exposed belong to the Belly River series, and lie on the northern extension of the low anticlinal which has been traced from the South Saskatchewan northward across Battle River.

"Chain of Lakes."

Following the river still further to the north, we pass through a wide, sloping, grassy valley, the surface being composed of fine-grained bedded clay, underlain by a sandy boulder-clay, till the river turns sharply eastward, and enters the "Chain of Lakes," a series of marshy lakelets which occupy the bottom of the valley for eighteen miles, and are imperfectly separated from each other by stagnant, sedgy creeks; the surrounding hills are covered with grass or small timber.

Two miles below the most easterly of the lakes, there is a low exposure of Pierre-like shales, including nodules of ironstone, and seven miles further down the stream and a mile and a half south of the fourteenth Base Line, rather hard yellow sandstone is seen in the hill-side, one hundred and twenty feet above the river, while in the bottom of the valley the following small section is exposed:—

	FEET. INCHES.	
Light-grey sandy shale.....	12	0
Light-grey soft sandstone.....	2	6
Dark-grey sandy shale containing traces of fossil plants.....	5	0
	19	6

Five miles further down the river, in which distance, only low croppings of shale or sandstone are seen, the following section is exposed with a light, but decided, dip up-stream:—

	FEET. INCHES.	
Light-grey soft clay-shale.....	2	0
Grey clay-shale, friable and rather carbonaceous at the top, interbedded with thin layers of olive sandstone.....	5	8
Dark-grey slaty carbonaceous shale with obscure impressions of plants, and showing in many places incipient concretions or concretionary rings.....	3	0
Olive-green soft sandstone containing a few nodules of ironstone and obscure carbonised impressions of plants.....	4	0
	14	8

Below this exposure, no rock is seen in place along the river till near the mouth of Birch Creek; the bottom of the valley is of hard clay, and its sides show white and light-grey clay and dark brown-weathering ironstone, which have every appearance of having been derived from the white beds of the Sub-Pierre.

Two miles above the mouth of Birch Creek, however, thin bands ^{Birch Lake.} of hard and soft yellow sandstone project from near the bottom of the bank. On Birch Creek itself, nothing is seen but dark-grey sandy boulder-clay. Around Birch Lake, the banks are generally sloping and grassy or lightly covered with brush, but at the northern extremity of its eastern arm, there is an abrupt escarpment, showing fifty feet of horizontal yellow soft sandstone interbedded with thin bands of similar but harder rock, and in a small island, half a mile from shore, sixty feet of similar rock are exposed. This is, without doubt, the same band of yellow sandstone which is exposed at intervals on Battle River above the mouth of Grizzly Bear ^{Yellow sandstone.} Coulee, and on Ribstone Creek a short distance above its mouth, ^{not the same as Rib. C.} and which was there seen to underlie a considerable thickness of true Pierre shales. On Vermilion River, also, three miles below the mouth of Birch Creek, there is an exposure of forty feet of similar soft yellow sandstone, with large nodules or concretions of ferruginous sandstone throughout, but still doubtless belonging to the same band as that seen on Birch Lake. As these two places differ in altitude three hundred feet and are fifteen miles apart, the dip of the rocks is shown to be twenty feet in the mile toward the east. Follow- ^{Easterly dip of rocks.} ing northward for a mile the small brook at the mouth of which this exposure occurs, we gradually rise through beds of apparently horizontal sandstone, till they are seen to be overlain by beds of dark-grey clay-shale, beyond which the sides of the little valley become sloping and grassy. In the valley of Vermilion river, below the mouth of this small tributary, similar sandstones crop out for a distance of

two miles and a quarter before they are carried beneath the level of the water by the low easterly dip, and the bank is then composed entirely of yellowish-grey friable clay-shale. For five miles further down the valley, small croppings of similar shale appear in low escarpments, and at the end of that distance, there is a slight exposure showing at the top, soft, yellow, thin-bedded sandstone underlain by dark-grey, sandy shale, with beds of nodular ferruginous sandstone. For the next fifteen miles, the valley is from one hundred to one hundred and fifty feet deep, with sloping banks wooded on the south side, but open and grassy on the north side. No rock was seen in place, though fragments of yellow lamellar sandstone, doubtless derived from rocks immediately underlying, were scattered about the face of the bank. At the end of the fifteen miles, a ledge of similar sandstone was seen cropping out in a small lateral coulée at the top of the bank. From this point down to the confluence of the Vermilion and North Saskatchewan rivers, the valley maintains very much the same character as before, the sides being sloping, and either grassy or wooded and often scattered over with a few large gneissoid boulders. In many places there are indications of underlying clay-shale, and thin beds of sandstone are sometimes seen, either projecting as ledges from the side of the hill, or in detached blocks on its face. No fossils were found till the mouth of the stream was reached, where a hundred feet of dark-grey clay-shale is exposed, holding crystals of selenite and numerous iron-stone nodules from which the following fossils were collected:—*Baculites ovatus*, *B. compressus*, *Inoceramus Sagensis*, *I. Vanuxemi*, and an undescribed *Periploma*.

Lower portion
of Vermilion
River.

Fossils.

NORTH SASKATCHEWAN RIVER.

The North Saskatchewan is a glacier-fed river, rising in the axial range of the Rocky Mountains, and flowing eastward across the northern edge of the Great Plains, after joining the South Saskatchewan, it debouches as the Saskatchewan into the north-western angle of Lake Winnipeg, from which it flows as the Nelson River, north-eastward into Hudson's Bay. The most part of its upper course is as yet unexamined geologically, but in the vicinity of Rocky Mountain House where our examination of it began, the rocks belong to the Paskapoo subdivision of the Laramie, and are composed of horizontal, slightly yellowish-grey, thick-bedded, massive, and generally hard sandstones, though with occasional softer bands. At the mouth of the Clearwater the following section is well exposed:—

Rocks at
Rocky Mountain
House.

	FEET.	INCHES.
Yellowish-grey, rather hard thick-bedded sandstone.	20	0
Bluish-grey sandy shale, often with a semi-conchoidal fracture, and holding traces of fossil plants...	20	0
Coal	0	8
Light grey compact sandstone.....	2	8
Coal	0	3
Carbonaceous shales	0	2
Coal	0	8½
Carbonaceous and sandy shale	2	0
Bluish-grey slightly sandy shale holding traces of fossil plants	2	0
	48	5½

The coal collected from the above section was examined by Mr. Hoffmann, and pronounced by him to be a lignitic coal, which, when freshly mined, would doubtless bear transportation, and is a tolerably firm fuel.

For fourteen miles up from its mouth or below the confluence of Clearwater River. Askowi Creek the Clearwater River was not examined, the trail which was surveyed by Mr. Hamilton, my assistant, in 1885, keeping on the higher ground to the east, but Dr. Hector ascended the stream on the ice in the winter of 1858, and writes of it as follows: "The banks of the river were high and steep, and present sections of the argillaceous sandstone, sometimes forming very picturesque and ruinous cliffs which peep out from among the dark green pines." *

Above Askowi Creek, the channel of the river is wide and very much obstructed by gravel bars. On one side of the stream, as far as the eastern base of the foot-hills, there is constantly a wide flat underlain by a thick deposit of quartzite shingle, while opposite it at the outer bends of the stream, the low hill-side is scarped, showing sections of horizontally bedded, light bluish-grey, rather hard coarse-grained sandstone. In the valley of Prairie Creek, a small tributary of the Prairie Creek. Clearwater from the west, similar sandstone is exposed in many places east of the Stoney Indian pack trail.

On the west side of the North Saskatchewan, to which we now return, and two miles below the mouth of the Clearwater, a seam of coal crops out close to the water's edge; the bank here is low, and covered with a deposit of quartzite shingle. Only the following section was here exposed :

	FEET.	INCHES.
Light-grey clay-shale containing obscure fragments of plants and numerous erect silicified stumps of trees, some of which, however, are turned into coal for a couple of inches around the outside	3	0
Coal.....	0	5
Grey clay-shale.....	0	8
Coal (at the water's edge) reported as about.....	2	0
	6	1

* Journals, Detailed Reports and Observations relative to the Exploration by Captain Palliser. London, Government, 1863, p. 75.

Coal seam.

This is undoubtedly the same seam as that seen in the cliff at the mouth of the Clearwater, though here it has become very much thicker and more compact. Coal was formerly obtained from this place by the servants of the Hudson's Bay Company, and used by them at the forge at Rocky Mountain House. It is a coal very similar to that obtained at Lethbridge, on the Belly River, and will keep for a length of time exposed to the air without crumbling, as large masses of it scattered along the banks of the river for many miles below its outcrop, and in some cases rounded off by the action of the water retain all their firmness.

The following is Dr. Harrington's report on specimens brought from this seam by Dr. Selwyn, in 1873 :—

Analysis of this coal.

"A bright black coal, breaking with angular fracture and giving a brick-red ash. Two proximate analyses by slow and fast coking gave—

	Slow coking.	Fast coking.
Water	7·82	7·82
Volatile combustible matter.....	31·35	38·00
Fixed carbon	54·97	42·25
Ash	5·86	5·93
	<hr/> 100·00	<hr/> 100·00"

Specimens from the same seam were collected by the writer in 1886, and analysed by Mr. Hoffmann, with the following result:—

	Fast coking.
Hygrosopic water.....	7·01
Volatile combustible matter	34·63
Fixed carbon	50·34
Ash.....	8·02
	<hr/> 100·00

The coke is non-coherent.

Fossil plants.

On the west side of the river the banks are high, and consist of yellowish-grey, coarse-grained sandstones, generally thick-bedded, but occasionally lamellar. Half a mile below the coal seam, thin bands of conglomerate with quartzite pebbles and a three-inch bed of limestone, are also seen, in the latter of which were found numerous remains of leaves of *Sequoia Langsdorffii*, Heer; *Sequoia Couttriae*, Heer; *Carya antiquorum*? Newberry; *Salix Laramiana*, Dawson; *Nelumbium Saskatchewanense*, Dawson; *Sapindus*, allied to *S. obtusifolius*, Lesq.; and species of *Populus*, *Quercus*, *Ficus* and *Carpolithes* (*Nyssidium*?).

* Geol. Survey Report for 1873-74, p. 63.

Along the river down to within half a mile of the crossing of the eleventh base-line, a distance of ten and a half miles below Rocky Mountain House, the west bank is a low alluvial flat underlain by quartzite gravel and covered, in most places, with spruce of fair size, while on the east side the bank, in a number of places, is high, showing escarpments of yellowish coarse-grained sandstone, apparently horizontal. Here are exposed thirty feet of yellowish-grey hard sandstone, changing gradually into bluish softer sandstone. The river soon turns again to the east side of the valley, leaving alluvial flats on its western bank as far as the mouth of Baptiste River. One and three-quarter miles below where the eleventh base-line crosses, the high-cut banks begin again on the east side, showing the following section:—

	FEET.	INCHES.
Grey and olive sandy shale holding a band of sandstone and nodules of limestone. In one band of lamellar sandstones near the top, specimens of <i>Sphaerium</i> and <i>Hydrobia</i> were found.....	80	0
Coal associated with fragments of silicified wood...	0	2
Sandy shale.....	20	0
Rather hard sandstone.....	30	0

From this point to near the mouth of the Baptiste River, twenty-five miles below Rocky Mountain House, similar sandstones and shales continue along the eastern bank, while the west bank is low and underlain by quartzite gravel and wooded with spruce and poplar.

Baptiste River, at its mouth, has a channel sixty feet wide, but when seen in September the stream did not average more than twenty-five to thirty feet, and was full of boulders which projected above the water, many being of reddish or dark-brown gneiss from twelve to sixteen inches in diameter. The water is beautifully clear and transparent, though with a slightly brownish tinge. Baptiste River.

Half a mile below the mouth of Baptiste River, in a high cliff on the west bank, thirty feet of coarse-grained, yellow, thick-bedded sandstone is seen underlain by eighty feet of greenish sandy and clayey shale with a thin seam of coal near the top, and a short distance further down the river numerous nodules of limestone occur in the shales.

Three and a half miles below the mouth of Baptiste River, similar sandstones and shales are again seen on the east side of the river, the lower beds being here one hundred feet thick, and as the fall in the river in this distance amounts to about twenty feet, the beds would appear to be quite horizontal, at least, in the direction in which the river is running. A mile further down, the valley widens and the

Expansion
of valley.

river winds for two miles through the wide flat which stretches between the steep banks on either side. This flat is underlain by ten feet or more of quartzite gravel covered with a thick bed of fine white silt, the river having evidently at one time expanded here even into a small lake, which, however, it has now drained by cutting through the band of hard sandstone that had dammed it back. Below this expansion the valley for two miles is narrow, with steep sides of olive shale and sandstone one hundred and fifty feet high. After this it again spreads out in a circular area about a mile in diameter, below which the stream flows between abrupt walls of hard, yellowish-brown, thick-bedded sandstone, with distinct false-bedding, underlain by grey and olive, sandy shale to the height of one hundred and

High cliffs of
hard sandstone. fifty feet.

From this point to the mouth of the Brazeau River, a distance of eleven miles, the valley is very irregular, though the sides are generally high and composed of yellowish-brown sandstone, and of grey and olive sandy shale, but the immediate banks of the river are often much lower, and show sandstones and shales at the bottom, overlain by quartzite pebbles which are again overlain by white silt.

Brazeau River.

Brazeau River is a stream of clear blue water, about as large as the Red Deer, flowing with a current of five miles an hour in a thickly wooded valley 130 feet deep at its mouth. Its bed is covered with rounded pebbles, and along its banks are scattered numerous boulders of gneiss with masses of sandstone, quartzite and concretionary limestone traversed by many thin veins of calcite.

It rises in the Rocky Mountains between the sources of the North Saskatchewan and of the Athabasca, but though its upper course has not yet been explored, it is probable, from the beautiful clearness of the water, that it is not fed by glaciers.

For eleven miles below the mouth of the Brazeau, the North Saskatchewan continues its course to the north, winding from side to side of the valley with an irregular current, at one time quiet and beautifully smooth, at another, rushing over its stony bottom in a series of rough rapids; making an average current in this distance of 4.6 miles an hour. The valley is 150 feet deep, with scarped banks of horizontal, soft light-grey sandstone and olive sandy shale on the outer sides of the bends, and bench land overlain by pebbles and silt on the inside of the curves. At the end of this stretch, the river bends sharply to the right and runs east for eight and a half miles to the mouth of Wolf Creek, which is a stream flowing in from the wooded country to the south, having at its mouth a channel seventy-five feet wide and five feet deep, with a stony bed. The water is brown but clear, and when I saw it in September, did not occupy more than a third of the width of the high-water channel.

Wolf Creek.

Just above this eastward bend in the river, a fine exposure of the rocks of the Paskapoo series is seen in a high cliff on the south-east side of the river, showing the following section:—

	FEET	INCHES.
Covered	20	0
Yellow and olive sandy shale.....	20	0
Irregular bed of hard, bluish limestone, breaking readily with uneven surface. In it were found obscure impressions of leaves and shells.....	12	0
Yellowish-grey sandstone.....	3	0
Bluish-grey, slightly sandy clay-shale.....	2	6
Yellowish-grey, rather harder and more coarse-grained sandstone.....	16	0
Coaly shale.....	1	0
Similar, but slightly darker sandstone.....	20	0
Soft bluish-grey, rather coarse-grained, thick-bedded sandstone, with an occasional harder nodular layer.....	100	0
	183	6

Some beautifully preserved leaves of *Viburnum asperum* and *Corylus McQuarrii* were collected from a slab of sandstone fallen from the face of the bank.

Between this exposure and the mouth of Wolf Creek, the valley is very irregular, occasional high scarped banks of sandstone and shale standing close to the water's edge, while at other places, wide wooded flats stretch back on either side into deep bays.

At the mouth of Wolf Creek the river turns to the left and flows N. 35° E. for twenty-nine miles, the valley on the whole being rather narrow and thickly wooded. Just below the mouth of the creek is an almost perpendicular bank, 100 feet high, of bluish-grey sandstone and clay-shale often very sandy with a band of concretionary limestone fifty feet from the bottom. A few fragments of fossil wood were collected from the sandstone, along with broken pieces of shells among which only the genera *Viviparus* and *Sphaerium* were recognisable.

Seven miles further down the river, a sharp bend in the stream brings us opposite a series of cone-shaped cliffs which were depicted and described by Dr. Selwyn in 1873.* They consist of one hundred and eighty feet of light bluish-grey sandy clay-shale, with bands and nodules of sandstone, overlain by twenty feet of rather hard, yellow thick-bedded sandstone forming a capping to and protecting the top of most of the cones. From these cliffs to a point eighteen miles below the mouth of Wolf Creek, the river winds among a number of low islands, flowing at the rate of three and a half miles an hour.

* Geol. Survey Report for 1873-74, p. 41.

The flats so far have been wooded with black and white spruce, with aspen and balsam poplar in the more open and drier places, but here balsam fir (*Abies balsamea*) of about six inches in diameter begins to appear along the edge of the water.

In this stretch, exposures of similar greenish-grey sandy shale and sandstone continue to be seen in the banks, which are, however, more and more covered by slides of silt and dark-coloured boulder-clay, the boulder-clay often including masses of coal of considerable size.

Coal seam.

Eighteen miles below Wolf Creek, at a slight bend in the river, and in a bank largely covered by slides of the upper superficial deposits, a seam of coal is seen. The whole bank shows a section somewhat as follows, the lower part only being accurately measured:—

	FEET. INCHES.	
Whitish fine-bedded clay.....	8	0
Dark-coloured boulder-clay.....	30	0
Covered.....	12	0
Bluish-grey, greenish-weathering, soft sandstone....	10	0
Covered.....	35	0
Coal.....	1	6
Black shale.....	0	2
Coal.....	1	3
Clay.....	0	1
Coal.....	1	10
Shale.....	0	6
Coal.....	2	0
Coarse friable sandy shale.....	1	1
Coal.....	8	6
Covered to water.....	12	0
	123	11

the whole lying apparently quite horizontally.

Sandstones
and shales.

For three-quarters of a mile below this point, the bank is completely covered with slides, and then horizontal, hard, thick-bedded yellow sandstone is exposed for twelve feet above the water, and a mile further down the stream, ten feet of hard greyish sandstone overlain by thirty feet of bluish and greenish-grey sandy shale and sandstone, apparently horizontal. For several miles beyond this point, the banks, on alternate sides of the river, show grey and olive sandy shale, overlain by dark-grey sandy clay and sand with pebbles, and above these a rather compact bedded sand, with a bed of broken coal sometimes appearing at the top of the shale; the beds lie horizontal, or with a very slight dip up stream. Just below the mouth of a small brook flowing in from the west, eight feet wide and two feet deep, and six miles below the coal outcrop described above, a seam of coal eight

feet thick, doubtless the same seam, is exposed a short distance above the water, in what is, perhaps, a slide from the bank behind, both overlain and underlain by rather hard sandstone. Two miles further down the stream, eight feet of light-grey thick-bedded sandstone is exposed at the water's edge, overlain by sixty feet of bluish and yellowish sandy clay-shale, with a four-foot band of yellow sandstone at the top,—and again, across a bend of the river, a similar section is exposed one hundred feet high, over the face of which fragments of coal are falling from some beds which are covered towards the top. Taking it for granted that the coal seam lies immediately on top of the beds exposed, we would have the base of the seam eighty-eight feet higher above the water than where it is first exposed, and as the difference of level is about fifty-four feet and the distance, in a straight line, six miles, it would leave a south-westerly dip for the beds of five feet eight inches to the mile. Extension of coal seam.

From this last exposure, the river turns and describes about three-quarters of a circle with the sun; it then flows east for eleven miles to Goose Encampment, the scarped banks showing the lower bed of hard sandstone gradually rising, with a dip S. 75° W. of sixteen feet to the mile, and a little further on, beds of yellowish-grey sandstone and bluish-grey sandy shale crop out near the water's edge.

Buck Creek, which empties into the Saskatchewan from the south, eight miles above Goose Encampment, has a channel at its mouth eighty feet wide and four feet deep, though, when examined, the stream was not more than twenty feet wide and six inches deep, the water being of a clear brown colour. Wide gravel bars stretch along the side of the Saskatchewan, and here, as in many other places, hide the mouth of the tributary stream. Buck Creek.

At Goose Encampment, the river turns again to the north-east, flowing in a very crooked channel for sixteen miles, as far as White Earth Creek. At this bend, a seam of coal is exposed at the edge of the water, no doubt the same seam which is very well exposed a short distance further down the river. In a straight line across country from the place where the last coal seam is first seen, on a bearing S. 75° W., the distance is seventeen miles, and taking the dip given above for this bearing, namely, sixteen feet to the mile, and allowing a fall of one hundred and fifty feet in the river in the distance, we have a thickness of about four hundred feet of yellow and grey sandstone and grey sandy shales between these two coal horizons. Coal seam at Goose Encampment.
Thickness of beds between the two coal horizons. As to the thickness of the beds above the upper of these coal horizons, no estimate could be made, the dips being slight and variable, and the character of the beds being so inconstant, that it appears to be impossible to trace them for any considerable distance, even in the same escarpment.

For several miles below the north-easterly bend of the river, this coal seam is seen to crop out, at intervals, along the bank; in one out-crop, that represented opposite page 13 E, the following section was measured:—

	FEET.	INCHES.
Light-grey, somewhat sandy, clay shale.....	6	0
Brown, somewhat carbonaceous, shale.....	1	6
Coal.....	10	0
Dark clay shale.....	1	2
Coal.....	10	6
Shale.....	0	8
Coal.....	4	6
Black carbonaceous sandy shale (to water's edge) ..	4	6
	<hr/> 38	<hr/> 10

Analyses
of coal.

Specimens from this seam were collected by Dr. Selwyn in 1873, and by Dr. Ells in 1875, and analysed by Mr. Hoffmann, with the following results:—*

"Structure, coarse lamellar; made up of alternate layers of more or less dense, bright and dull coal, and numerous interstratified layers of mineral charcoal; the surface of the denser layers parallel to the plane of deposition presents a ligneous structure; color black; lustre along the surface of bedding dull, that of the cross fracture sub-resinous to resinous; fracture uneven, that of the brighter layers, somewhat conchoidal; the brighter portions do not soil the fingers; powder almost black; it communicates a deep brownish-red colour to a boiling solution of caustic potash; by exposure to the air, becomes fissured, preferably along the line of bedding, and falls to pieces.

"Specific gravity 1.4341—Weight of one solid cubic foot 89.63 pounds.

"Analyses by slow and fast coking gave:

	Slow Coking.	Fast Coking.
Hygroscopic water.....	14.78	14.78
Volatile combustible matter.....	28.46	30.48
Fixed carbon.....	50.69	48.67
Ash.....	6.07	6.07
	<hr/> 100.00	<hr/> 100.00
Coke, per cent.....	56.76	54.74
Ratio of volatile combustible matter to fixed carbon.....	1:1.78	1:1.59

"Calorific power—determined by experiment:

Indicated power of fuel in calories.....	52.89
Indicated evaporative power.....	9.84 pounds
of water (at 100° C.) per pound of fuel.	

* Geol. Survey Report for 1882-84, p. 13 M.

"It yields, both by slow and fast coking, a non-coherent coke; the gases evolved during coking burnt with a yellowish, slightly luminous, almost smokeless flame. The ash has a pale brownish color,—exposed to a bright red heat, it becomes very slightly agglutinated, at a most intense red heat, it becomes slightly fritted."

For four miles below this last mentioned outcrop, the banks show nothing but slight exposures of light-grey sandstone and sandy shale, and then the same coal seam rises in a low anticlinal (figured and described by Dr. Selwyn in 1873,*) and shows essentially the same section as that given above.

It has long been known that this is about the highest point on the river, where gold can be washed out of the gravel and sand bars in paying quantities, and prospectors on that account have been led to examine the banks in this vicinity very closely. In sections 35 and 36, township 50, range 4, west of the fifth principal meridian, the coal seam has been burnt out over a considerable area, and the ground is now scattered over in many places with large masses of a slag-like rock, and where these have not been covered with the alluvial deposits, beds of ashes and burnt clay and sandstone skirt the edge of the bank of undisturbed coal-bearing strata. A number of specimens of this burnt material were collected and have been assayed in the laboratory with the following interesting results:

Two masses of slag-like rock lying at the foot of the slope in which the coal seam is exposed, taken from places one mile apart.

Trace of gold.

Arenaceous clay-shale underlying coal seam.

Trace of gold.

Ashes from burnt coal seam.

Trace of gold.

A trace of gold was also found in the parting of clay-shale in the coal seam where it had been unaffected by fire. A sample of the overlying boulder-clay was also assayed, but no gold could be detected in it.

On the west side of the river, a mile and a-half below the low anticlinal outcrop of coal above-mentioned, the seam has been burnt out and is seen to be underlain by fifty feet of whitish clay and clayey sandstone, quite different in appearance from any of the light-grey argillaceous sandstone which we have yet met with in this river, and precisely similar to the whitish clays and sands seen on the Red Deer from the mouth of Tail Creek to the mouth of Rosebud Creek, forming the upper beds of the Edmonton series.

The coal seam is here overlain by fifteen feet or more of grey sandy

* Geol. Survey Report for 1873-74, p. 49.

Top beds of
Edmonton
series.

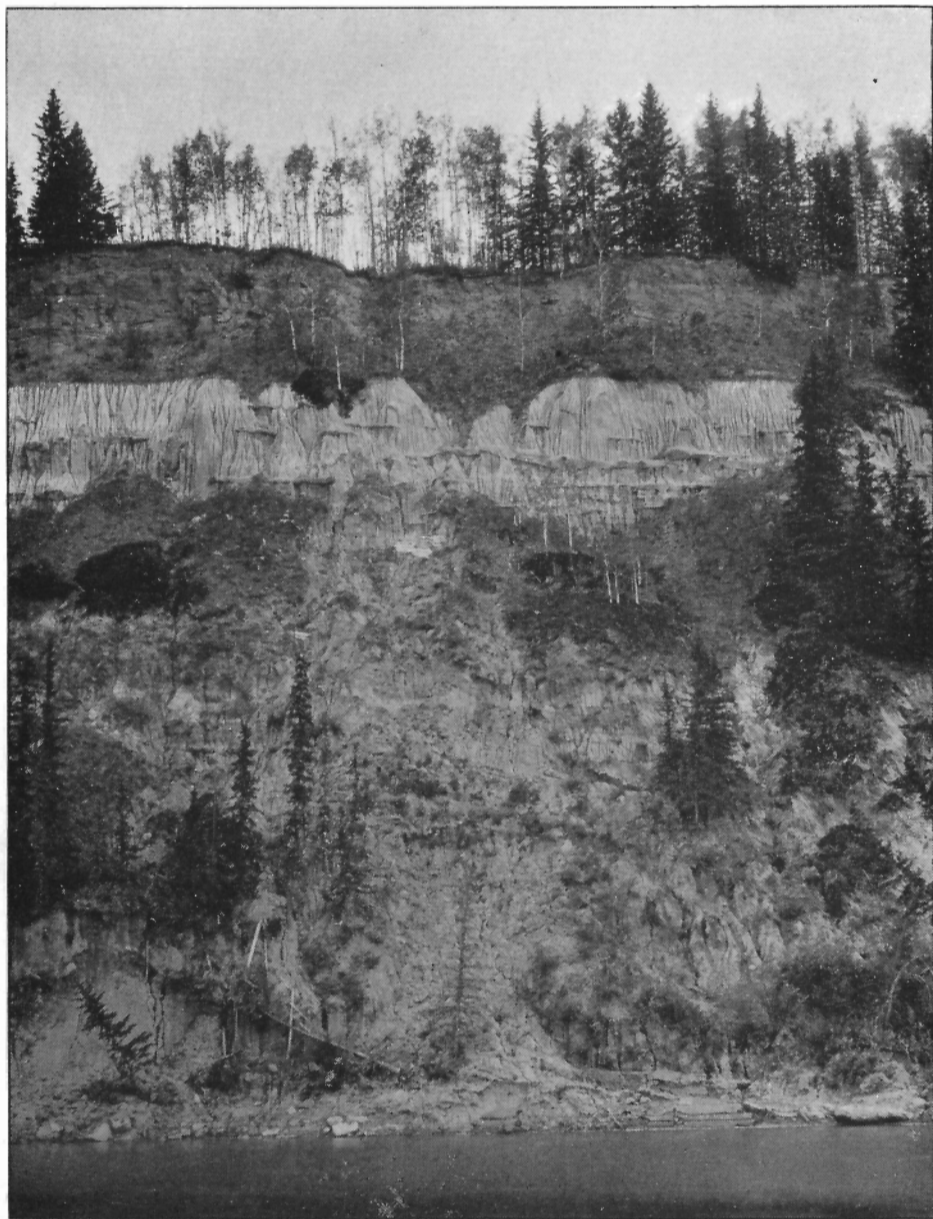
shales with beds of yellow sandstone, in which are found remains of leaves of *Populus arctica*, *Populus Richardsoni*?, *Taxodium occidentale*, *Sequoia Langsdorffii*? and *Onoclea sensibilis*.

The beds of white clay and sand now rise gradually to the top of the banks on either side, bringing with them numerous seams of coal, varying from a few inches to several feet in thickness, as well as a few bands of nodular ironstone. A fairly typical section may be seen just below the mouth of White Lake Creek, viz:—

Section.	FEET. INCHES.	
	FEET.	INCHES.
Superficial deposit of stratified sand.....	12	0
Coal in uneven bed, partly or largely eroded at its thickest part.....	6	0
Almost black, somewhat shaly, unctuous clay.....	0	3
White " " " ".....	0	2½
Brown, rather sandy, clay.....	0	2½
Light-grey, rather sandy, clay-shale.....	4	0
Soft, coarse-grained, light-grey sandstone with some bands of nodular ironstone.....	7	0
Light grey, sandy shale.....	4	0
Impure coal.....	0	8
Light-grey sandy clay-shale, and soft clayey sandstone.....	16	0
Soft dark-coloured clay-shale.....	0	8
Black fine-grained sandy shale containing a considerable quantity of coal.....	0	6
Coal.....	0	6
Similar black sandy shale.....	1	4
Light-grey sandstone and shale.....	18	0
	71	4

Whitefish Lake
Creek.

Whitefish Lake Creek is a swift stream of clear brownish water, flowing southward out of Whitefish Lake which lies about ten miles north of the river. The channel is twenty feet wide and ten feet deep, with a bottom of gravel or sand. In September, the stream was fifteen feet wide and one foot deep. One mile and a half below the mouth of Whitefish Lake Creek, another stream five feet wide and eighteen inches deep, flows in from the north out of a wide, sloping valley, draining a lake which lies a short distance to the north. It was on the beautiful flat at the mouth of this creek that the Hudson's Bay Company had one of their old trading posts, which they called White Mud Fort, the ruins of the chimneys of which can still be seen standing like conical mounds in the midst of the long grass. From the mouth of this creek, known as White Mud Creek, the river turns abruptly and runs to the south for four miles, the banks being high on the east side, but on the west side there is a wide



J. B. TYRRELL, PHOTO., SEPT., 1886.

IVES-PROCESS ; G. E. DESBARATS & SON, MONTREAL.

BANK OF NORTH SASKATCHEWAN RIVER, 40 MILES ABOVE EDMONTON, ALBERTA ;
SHOWING BEDS OF THE EDMONTON SUBDIVISION OF THE LARAMIÉ.

thickly-wooded flat for two miles, and then on that side, also, the bank is abrupt and high. Here the river valley becomes deep and narrow, and is bounded on both sides by banks of whitish sandstone and clay of the Edmonton series, coal seams showing themselves here and there in dark lines in the light-coloured clays and muds. After flowing four miles in a southerly direction, the river turns sharply, and runs in a general easterly direction for twenty-six miles, the valley retaining its gorge-like character, with banks 150 to 200 feet high, and with narrow flats densely wooded with large spruce. The banks however, are very much obscured by slides, so that good sections are rare, and it is very difficult to follow any beds or seams for any considerable distance. The plate on the opposite page gives a very fair idea of the general style of the scarped side of the valley, the opposite side, though steep, being generally covered with timber and underbrush. The following section may be taken as a fairly typical one, and reminds one very much of some of the sections on the Red Deer River:—

	FEET. INCHES.		Section fairly typical of Edmonton series.
	FEET.	INCHES.	
Boulder-clay, at the top.....			
Light-grey sandy clay-shale and clayey sandstone..	30	0	
Grey sandy shale.....	4	0	
White plastic clay.....	0	8	
Dark clay-shale.....	1	4	
Coal.....	2	0	
Plastic clay.....	0	7½	
Coal.....	2	2	
Dark coarse clay-shale.....	5	6	
Coal.....	1	1	
Dark coaly shale.....	1	2	
Soft, black, plastic clay.....	2	0	
Dark, friable, irregularly-fractured clay-shale, burning to a fine red terra-cotta-like mass.....	3	2	
White and dark plastic clay.....	0	5	
Stony coal.....	0	4	
Rather dark grey fine clay-shale.....	1	0	
Stony coal.....	0	9	
White plastic clay.....	0	9	
Coal.....	2	10	
Light grey, sandy clay-shale, and clayey sandstone, with thin seam of impure coal, 6 feet from the bottom.....	35	0	
	94	9½	

The clay and sandstone banks when not otherwise wooded, are sometimes dotted with small sage-bush. It is in this stretch, a short distance west of the fifth principal meridian, that the old location of

the Canadian Pacific Railway crosses the Saskatchewan at an elevation of 2,200 feet above the sea and one hundred and four feet above the bed of the stream.

Several small streams fall into the river here from the south, but they have already been described, as far as known, on a previous page.

At the end of this easterly stretch the river makes a horse-shoe bend to the south and then flows off in a north-easterly direction. At the bend the following section is seen:—

	FEET. INCHES.	
Bedded superficial sand.....	20	0
Seam of carbonaceous shale.....	1	0
Light-grey sandy clay-shale holding a good many irregular nodules of ironstone and some thin seams of sandstone.....	40	0
Coal, for the most part, rather stony.....	2	8
Grey unctuous clay.....	0	2½
Coal, somewhat shaly towards the bottom.....	1	3
Black thin-bedded carbonaceous shale.....	0	10½
Coal.....	2	0
Grey clay-shale and clayey sandstone.....	120	0
Coal.....	2	8
Soft light-brown clay-shale.....	16	0
	<hr/> 206	<hr/> 8

The beds, for the last thirty miles down the river, seem to be lying perfectly horizontal, for though there appears to be a dip of a few feet to the mile up the river, it is probably no greater than the fall of the river in the same distance.

At the horse-shoe bend the river turns sharply in a direction N. 40° E. and continues in that direction for sixty miles in a straight line, or seventy-five miles following the course of the river.

At the head of Big Island, five miles below this bend, a seam of coal three feet eight inches thick, crops out eighteen feet above the water, overlain by sixteen inches of hard whitish sandy clay; it is, doubtless, the same seam as that seen at the edge of the water near the bend, and sixteen feet above it in the last preceding section. A proximate analysis of a specimen from this seam gave Mr. Hoffmann:—

Hygroscopic water.....	8.92
Volatile combustible matter.....	28.70
Fixed carbon.....	37.44
Ash.....	24.94
	<hr/> 100.00

Big Island
coal seam.

From Big Island to Edmonton, a distance of twelve miles, the river is winding, and bounded by banks of whitish sandstone and clay, two hundred feet high, though on account of the increased width of the valley, some beautiful flats extend along either side of the river. The banks are everywhere concealed by slides, and often also by underbrush, so that no sections could be seen. At Edmonton, a coal-seam four feet thick crops out on the south bank of the river, forty feet above the water; a small quantity of coal was mined from it; but lately, Mr. Donald Ross has run a drift into the north bank through a mass of quartzite pebbles slidden from above. The seam consists of three feet of good workable coal, overlain by about one foot of dark clay-shale, which is again overlain by a considerable thickness of impure coal. It has not been found advisable to work this upper part of the seam, but it forms a very good roof for the drifts and rooms. The coal is being used in Edmonton at the different forges and throughout the town generally. It burns well, both in stoves and open grates, making a beautiful clear hot fire, and when stored under a roof, can be kept for a long time in a perfectly serviceable [condition; some which had been lying in a shed for a year was still in lumps of fair size, and when burned, made an excellent fire.

A proximate analysis of a specimen from this seam, but from the south side of the river, gave Mr. Hoffmann:—

Hygroscopic water	11.47
Volatile combustible matter	36.12
Fixed carbon	48.57
Ash	3.84
	<hr/>
	100 00

There is stated to be another seam about two feet thick in the bed of the river, but I was not able to see it on account of the height of the water. A soft unctuous clay has been several times mentioned as occurring along with the beds of coal. Some of this clay was collected from here by Dr. Selwyn in 1873, and analysed by Mr. Hoffman, who, in the appendix to Dr. Selwyn's report,* described it as follows:—

"Silica	36.48
Alumina	13.48
Protoxide of iron	1.80
Lime	2.03
Magnesia .....	.66
Water, (loss by ignition)	44.32
	<hr/>
	98.78

* Geol. Survey Report for 1873-74, p. 64.

"Alkalies were not determined, though they probably make up the deficit. The material was not dried, but analysed in the moist condition in which it came from the bed. Its colour is pale greenish-grey; consistence that of soft dough; unctuous; when rubbed on the hand with a little water has a soapy feel, and possesses detergent properties; readily parts with its water, even at the ordinary temperature of the atmosphere. After drying at 100° C. may be reduced to an almost impalpable powder, which on being moistened with water, assumes all its original physical characters."

Rich alluvial
flats.

From Edmonton to the mouth of Sturgeon Creek, a distance of twenty-eight miles, the river winds from side to side of a rather deep, wide valley, leaving fine alluvial flats alternately on either side, on many of which settlers have already located, and the small breakings here and there, yielding rich crops, give promise of the great agricultural prosperity of this country in the not far distant future. Opposite the flats, cut-banks are generally seen, showing light-gray sandy shale and whitish clayey sandstone, with many outcrops of small seams of coal, reminding one very much of the beds in the lower part of Rosebud Creek, of which, in fact, they are the northerly continuation, except that here there is not quite so much variety in colour, and, owing to the greater rainfall, the banks are rather more sloping, trees and shrubs are growing wherever they are able to take root, and there are no "bad lands."

Pre-glacial
gravels and
sands.

Above the sandstones and clays of the Laramie, we have in this section of the valley some good exposures of pre-glacial river gravels and sands: one exposure, just at the eastern end of the town site of Edmonton, showing eight feet of quartzite shingle, overlain by twelve feet of yellowish sand, into which the shingle runs up in irregular tongues in many places, showing the whole to be essentially one deposit. This is overlain by a massive sandy clay, mostly dark-coloured, containing numerous pebbles and boulders, to a thickness, as seen in some places, of twenty-five feet, and breaking along numerous joints with almost perpendicular faces. The height of the bottom of this boulder-clay varies very much with the irregularities of the surface of the underlying rock; on the higher banks it is often more than a hundred feet above the river level, and lies immediately on the Laramie, while in the valley it sometimes comes within a few feet of the level of the water, and is invariably underlain by sand and quartzite gravel.

Boulder clay.

No general dip
in underlying
rocks.

No general dip can be detected in the Laramie rocks on this part of the river, though they sometimes appear to incline a few feet in the mile in one direction and sometimes in another.

Sturgeon Creek has its source in, or rather above, Lake St. Ann, thirty-six miles N. 75° W. from Edmonton, and flows a little south of east till it reaches Big Lake. Leaving Big Lake, which has an area of about six square miles, it runs for twenty-one miles towards the north-east, parallel to the Saskatchewan and at a distance of from ten to twelve north-west from it; the creek then turns sharply at a right angle and flows south-east to its mouth. At the point where the trail crosses it, it is twenty feet wide and one foot deep, with a rapid current, in a valley half a mile wide and one hundred and fifty feet deep.

The banks of the North Saskatchewan are here sloping and grassy or lightly wooded. To the mouth of Beaver Creek, a distance of thirteen miles, they preserve very much this same character, a few escarpments being seen, which, however, were found to be composed almost entirely of drift deposits, usually sand and pebbles overlain by boulder-clay. Midway between the two creeks, two feet of dark-grey clay-shale crop out at the water's edge, associated with nodules of light-brown ironstone and large lenticular masses of ferruginous sandstone, with a dip S. 45° W. of eighty feet to the mile. This bed is precisely similar to that seen on Beaver Creek, at the crossing of the Victoria and Edmonton trail, and may represent the top of the Pierre shales brought up by the continuation of the low anticlinal which, further to the south, brings the beds of the Belly River series to the surface, but, as no traces of fossils could be found, it was impossible to decide this point, and it has not been considered advisable, at present, to indicate it with the Pierre colour on the map.

Low exposure
of dark-gray
clay shale.

A mile further down, dark shale is seen on the north bank of the river, overlain by fifty feet of light-grey sandy shale and whitish clayey sandstone holding nodules of ironstone and bands of ferruginous sandstone. Then to the mouth of Beaver Creek and for five miles below it, a distance of ten miles, the banks are sloping and generally well wooded with poplar, mixed with some spruce, with here and there cut-banks of sand often overlain by boulder-clay. On Beaver Creek itself, near its mouth, steep scarped banks of yellow sand interbedded with blue shaly clay, both containing pebbles of gneiss, quartzite, ironstone, etc., rise abruptly from the edge of the water for seventy feet. If the dip of eighty feet to the mile obtained above continues for these ten miles where the underlying rocks are covered with drift, the distance would be quite sufficient to allow the Pierre shales to cross the river, as it is not at all probable that they would have a thickness of more than six to eight hundred feet, but this is a point which for its determination will require further research in the small lateral gulleys, or perhaps even by boring.

Banks composed of superficial deposits.

Five miles below the mouth of Beaver Creek, where the river turns slightly towards the north, grey clay-shale and whitish clayey sandstone are again seen. These contain nodules of sandy ironstone and bands of yellow ferruginous sandstone, the whole exposure presenting a scarped face twenty feet high. Its height gradually increases down the river, till, opposite the mouth of Sucker Creek, it is one hundred and fifty feet high, and is entirely composed of light-grey and whitish clayey sandstone and grey clay and sandy shale containing, especially towards the top, numerous flint-like nodules of ironstone, as well as irregular bands of yellow ferruginous sandstone. The otherwise naked face of the cliff is covered here and there with a few sage-bushes. This rise gives a dip to the beds, in a southerly direction, of thirty feet to the mile, and supposing the true direction of dip to be south-westward, which has been found to be the general direction of the dip throughout the western portion of this district, the beds would have a dip in that direction of about forty-five feet to the mile. The dip, fourteen miles further up the river, was seen to be eighty feet per mile, and, taking the mean of these two instances, we would have a general dip of sixty-two and a half feet to the mile and a thickness of eight hundred and seventy feet for the strata exposed in that direction.

General dip
of beds.

From the mouth of Sucker Creek, the river flows 30° east of north for two miles, the banks being composed of light-coloured clayey sandstone and sandy shale; it then makes a sharp bend to 25° south of east, and sixteen miles lower down it gradually turns to the east and then to the north of east, till the mouth of White Earth River is reached. For eighteen miles of this distance, as far east as Victoria, the country to the north is open or but lightly wooded, stretching back in a beautiful plain from the sloping bank of the river; the south bank is high and thickly wooded, but showing, in many places, exposures of the whitish clayey sandstone, at heights varying from the water's edge to one hundred feet above it. Thin seams of coal also crop out at several places, though none were seen which would be of any service except for local supply.

Attractive
country.

Section on
Egg Creek.

The following section is well seen in the deep, narrow valley of Egg creek, about a mile south of where it flows into the North Saskatchewan opposite Victoria:—

	FEET.	INCHES.
Grey, somewhat sandy, clay-shale, coaly towards the top.....	4	3
Nodular ironstone.....	0	2
Soft light-grey sandstone.....	1	3
Brownish-grey shale with thin streaks of coal and nodules of ironstone.....	1	6

	FEET.	INCHES.
Dark coaly shale.....	0	6
Light-grey sandy shale.....	1	10
Soft grey sandstone.....	1	3
Impure <i>lignite</i>	0	6
Drab-coloured sandy clay-shale.....	2	3
Bluish-grey soft sandstone, in places harder and false-bedded.....	9	0
Reddish-grey clay, but mostly covered.....	1	6
Fine grey clay-shale.	1	0
Thinly-laminated coaly shale.....	1	0
Light-grey clay-shale.....	2	0
Sandy shale.....	0	6
Light-grey clay-shale.....	3	6
Light-grey soft sandy shale and sandstone.....	6	0
Light-grey sandy clay-shale.....	3	0
Grey, partly carbonaceous, clay-shale.....	1	6
Grey clay-shale, dark at the top but becoming quite light at the bottom.....	5	9
Light-grey fine clay-shale with some thin bands of blueish-grey, soft sandstone.....	15	0
Coal.....	1	3
Carbonaceous shale.....	0	10
Light-grey sandy shale.....	7	0
Light-grey clay-shale with bands of ironstone.....	6	0
Coal.....	1	1
Covered (probably mostly light-grey shale).....	20	0
	99	5

Some specimens of coal collected from the lowest of these seams, Coal on Egg Creek, were analyzed by Mr. Hoffmann and found to contain:—

Hygroscopic water.....	11.91
Volatile combustible matter.....	36.39
Fixed carbon.....	45.04
Ash.....	6.66
	100.00

From the mouth of Egg Creek, for about four miles down the river, no rocks are seen in place, and then the whitish clayey sandstones have disappeared, and instead we have low exposures of light-grey and yellow soft sandstone containing large lenticular concretionary nodules of hard grey yellow-weathering sandstone, usually false-bedded and often holding, close to their lower surface, nodules of flinty ironstone and fragments of silicified wood.

From the outcrop of the Big Coal Seam, opposite Goose Encampment, to the mouth of Egg creek or a little east of that point, we have con-

Extent of
Edmonton
series on the
North
Saskatchewan.

sidered the beds as all belonging to our lower division of the Laramie, namely, to the Edmonton series. As far east as the mouth of Sturgeon Creek, there can be no doubt that this is the true position of the rocks seen, as they can be traced in, practically, an unbroken section, for the whole distance. East of Sturgeon Creek, the geology, as made out on this one section down the river, is not so clear, as the rocks are not constant in their character, and when seen, have an appreciable dip which might carry a formation only a few hundred feet in thickness, across the section without a trace of it being seen. In the entire absence of palæontological evidence of the age of the beds, though fossils were carefully searched for wherever any exposures of the underlying rocks were seen, and considering the undisturbed condition of the rocks throughout the whole district, we feel justified in assuming that the light dip towards the south-west in this portion of the country, is constant, and that every mile in a north-easterly direction takes us into lower beds. It is not at all improbable, that the discovery of fossils may at any time show that the line of the bottom of the Edmonton series has been drawn too low, but at present we have nothing to guide us but the change in the character of the rocks, as seen above, from soft light-coloured argillaceous sandstone and shale, to purer sandstone, a change observed in numerous places further south, where we pass from the lowest beds of the Laramie to the sandstone of the Fox Hill group. It is possible, too, that the soft white sandstones which crop out around the northwesterly angle of the North Saskatchewan, may belong to the underlying Belly River series, but as they are, certainly, the same beds which extend as far west as Victoria, there is nothing to indicate a dip to the north-east sufficiently steep to carry down again, not only the exposed beds of the Belly River series, but also all the lower beds of the Pierre, for we will see shortly that the yellow sandstones, outcropping four miles to the east of Victoria and for a considerable distance further down the river, are underlain by dark clay shales, of the Pierre group.

Uncertain age
of some of
the beds.

From a point four miles below Victoria to the mouth of the White Earth River, a distance of four miles, grey and yellowish sandstones are exposed at intervals along the south bank in cut-banks thirty feet high. Just below the mouth of White Earth River, the North Saskatchewan turns sharply to the north, and the banks become more sloping, being covered with small poplar mixed with some spruce. Concretionary sandstone is, however, seen in several places close to the river, underlain by dark friable clay-shale, as seen in the following section:—

Concretionary
sandstone.

	FEET.
Stratified sandy clay.....	5
Light-yellow sandstone with large sandstone concretions.....	8
Dark-grey clay-shale, in some places sandy or including beds of sand; it holds a few large lenticular nodules of calcareous ironstone.....	30

Five miles below White Earth River, the North Saskatchewan turns more to the east, and flows on a bearing S. 30° E. for twelve miles, the banks are composed of horizontal beds of grey sandy shale, and grey and yellow concretionary sandstone, and become gradually higher down the stream.

The river now turns due east to the mouth of Saddle Creek, high hills Sandy shale. skirting it on either side. The sandstones gradually disappear, rising up over the tops of the banks; and low outcrops of somewhat sandy shale, close to the edge of the river, are all that is seen of the underlying rocks. On Saddle Creek, a short distance from its mouth, yellowish-grey shale is seen for 120 feet above the water, overlain by a band of soft sandstone, above which there are no exposures, though the banks are sandy. The valley is here 350 feet deep and very wide, with rough uneven slopes on either side, presenting steep hills and ridges caused by slides of the overlying clay. They are here thickly covered with berry bushes, though in the more rainless areas further south the same cause gives rise to perfectly bare bad-land banks.

Five miles above the mouth of Saddle Lake Creek, at the old crossing Crossing of Lac La Biche trail. of the Lac La Biche trail, the valley is thus spoken of by Dr. Hector, who visited it in 1858:—"The country bordering the river in this part of its course is very beautiful, as the high banks retire and form, by combining with a still higher table land, undulating hills that rise to a height of 300 to 400 feet. On the north side are thus formed the Snake Hills, which are free from wood except in the ravines."*

From the mouth of Saddle Lake Creek, which is a small stream twelve feet wide and one foot deep, the river flows to the south, in a wide sloping valley, in the sides of which the rocks are almost entirely hidden by slides of superficial deposits or by the thick growth of herbage and underbrush. In two or three places, however, close to the edge of the water, grey clay-shale crops out, holding nodules and concretions of ironstone and ferruginous sandstone. At the end of this southerly stretch, the river turns sharply to the east passing the old Roman Catholic Mission of St. Paul, now deserted. The Old mission of St. Paul. The valley here is bounded by beautiful terraced banks rising at a distance of about a mile on either side to a height of two hundred feet. The

* Journals, etc., relative to the Exploration by Capt. Palliser, p. 80.

north bank presents a beautiful strip of open prairie, while to the south, the terraces are covered with willow and berry bushes. Low exposures of dark clay-shale with ironstone nodules are also seen along this stretch. The character of the valley from old St. Paul down to Fort Pitt, is very constant, sloping banks rising on either side into higher or lower hills, often by a series of terraces, the south bank being generally much more thickly wooded than the north. There are very few rock exposures, and those consist of clay-shale with septarian nodules, till we approach the mouth of Moose Hill Creek, opposite Island No. 14, where a scarped bank is seen one hundred feet high of dark slate-grey clay-shale with lenticular nodules of calcareous ironstone, in which have been found some fragments of the following typically Pierre fossils, viz.: *Baculites ovatus*, *B. compressus*, *Scaphites nodosus*, *Pholadomya subventricosa*, and a species of *Inoceramus*. Between the mouth of Moose Hill Creek and Vermilion River, the banks are still sloping and occasionally show small exposures of similar dark clay-shale containing a few scattered remains of *Baculites*. At the mouth of the Vermilion, an excellent section one hundred feet high, is exposed of the dark clay-shales of the Pierre group, holding, towards the top, numerous crystals of selenite, as well as a band of calcareous ironstone, and a thin band of yellow soapy clay. In the ironstone were found the fossils mentioned on page 100 E. Between the mouth of the Vermilion River and Fort Pitt, which is situated nine miles beyond the easterly limit of the accompanying map, a few low exposures of dark clay-shale were seen close to the edge of the water, and in several places on the bank the rock had slidden down, and exposed fine sections of dark clay-shale, from some of which the following fossils were collected: *Baculites ovatus*, *B. compressus*, *Inoceramus Sagensis*, *I. Vanuxemi*, *Pholadomya subventricosa*, *Thetis* ? sp. and *Martesia tumidifrons*.

Pierre fossils.

FOOT-HILLS.

Shown in the south-west angle of the accompanying map, and occupying an area of eleven hundred square miles, is a district which has originally been forest-clad, but the greater part of the finer timber has of late years been burnt, and is now scattered over the ground in extensive stretches of wind-fall. The country is essentially a succession of long sandstone ridges separated by narrow valleys, the bottoms of which are usually impassable morasses; in some places, these are firm enough to support a growth of small spruce and tamarac, while often they are very soft and covered with moss or rank tufted grass. On account of the almost inaccessible character of this district

Foot Hills.

it has been impossible for me to examine it in any detail in the short time which has been devoted to the whole region embraced in this report, and the remarks made here apply more especially to the outer and eastern portion of the hills.

The foot-hills are generally marked off from the Rocky Mountains proper by the line of outcrop of a great fault which runs roughly in a north-north-westerly direction, and brings the Palæozoic limestones into contact with the softer Cretaceous and Laramie shales and sandstones, the limestones rising in an abrupt mural escarpment from two to three thousand feet above the top of the highest of the foot-hills.

The line of the eastern edge of the Palæozoic rocks is drawn on the map from a sketch kindly furnished me by Mr. McConnell of this Survey, whose report forms Part D. of the Annual Report, 1886.

The streams which drain these hills, enumerated in order from south to north, are the Bow, Ghost, Little Red Deer, Fallen Timber, Red Deer, James and Clearwater rivers, all of them streams of clear blue water from the mountains. Streams drain-
ing the Foot
Hills.

On the Bow River, a short distance east of the mouth of Coal Creek, the sandstones of the Laramie begin to show a decided dip eastward, and close to the mouth of the creek, sandstone and shale crop out with a dip N. 70° E. of 30°, bringing to the surface a seam of bituminous coal. The following section was obtained on the creek, a short distance from the river, at a place where a few years ago a small quantity of coal was taken out for local use :— Bow River
coal seam.

	FEET.	INCHES.
Compact grey sandstone.....	30	0
Shale and ferruginous sandstone	4	0
Coal, with a thin parting of clay running through the middle	2	10
Shale	15	0
Hard grey sandstone.....	5	0
	<hr/> 56	<hr/> 10

The coal is generally lamellar, though towards the bottom of the seam it breaks off in lumps of moderate size.

Following the strike of the beds, the "Bow River Mining Company" sank a shaft on the south side of Bow River and succeeded in striking the coal a few feet below the surface. The following section obtained at this point was kindly furnished to Dr. G. M. Dawson by Mr. J. W. Vaughan :—

	FEET. INCHES.	
Rock .....	..	..
Coal	1	0
Black shale.....	2	9
Coal	1	6
Clay	0	4
Coal	2	6
Clay	0	2
Coal	2	7
Warrant .....	..	..
	10	10

Analysis of
coal.

Specimens from both of the above localities were analysed by Mr. Hoffmann, of the survey, with the following results:—

From north of the Bow River: *

	<i>Slow Coking.</i>	<i>Fast Coking.</i>
Hygroscopic water.....	4·93	4·93
Volatile combustible matter.....	27·22	33·55
Fixed carbon.....	52·54	46·21
Ash	15·31	15·31
	100·00	100·00

From the mine to the south of Bow River:

	<i>Fast Coking.</i>
Hygroscopic water.....	4·41
Volatile combustible matter.....	40·32
Fixed carbon.....	48·27
Ash.....	7·00
	100·00

The coke is firm and compact.

From the two sections given above, it will be seen that the seam is very variable in thickness, as it changes from two feet ten inches to seven feet seven inches in the short distance of three-quarters of a mile. The coal, however, is of excellent quality, and this seam will, doubtless, be an important source of supply throughout all the parts of the North-West Territory and Manitoba, to which it can be carried by rail.

Laramie age
of seam.

This seam is of undoubted Laramie age, but, whether as low as the beds of the Edmonton series, it is difficult to say in the absence of all palæontological evidence, and especially as the rocks of this series along their western outcrop have lost all, or almost all, the main peculiarities which on the plains serve to mark them off sharply from the beds both above and below them.

* Geol. Survey Report for 1882-84, p. 32 M.

Half a mile west of the mouth of Coal Creek, a sharp anticlinal crosses the river, and from that point westward, sandstones and dark clay-shales are met with, usually inclined at a high angle and folded backwards and forwards on each other in a very intricate manner. In these folded rocks the few fossils that have been collected give evidence of the presence of the Laramie, the Pierre, and the Benton, while at Canmore and further south, plant remains were collected by Dr. G. M. Dawson, which proved the presence of rocks still lower down in the Cretaceous.

On the west side of the valley of Spencer Creek, a mile above the crossing of the Calgary-Morley trail, dark-grey clay-shales are seen dipping westerly, and including, along with bands of sandstone and ironstone, a twenty-inch seam of finely powdered coal, and four feet above the coal, there is a band of shale rather harder than the rest, holding numerous imperfect impressions of leaves. Then, passing westward, over a ridge of sandstone, which is also dipping westerly at a high angle, we reach the dark shales again in the valley of Ghost River. Up this stream, the shales gradually change to sandy shales and sandstones, and at a distance of two miles from Bow River, a sharp, synclinal crosses the valley with a strike N. 19° W., the beds suddenly changing from a high dip, S. 71° W., to a dip of about 30°, N. 71° E. A third of a mile further up the stream, at a point where a small brook flowing in a deep, narrow valley, joins the river from the south-west, the last-mentioned sandstones and sandy shales, which are of a grey or slightly olive colour, are underlain by dark clay-shales holding thin bands of ironstone nodules as well as beds of hard sandy argillite mixed with iron pyrites and some fragments of marine cretaceous fossils, such as *Inoceramus*, *Modiola*?, etc. It would appear highly probable that these shales belong to the horizon of the Pierre, while the sandstones and sandy shales which overlies them are of the age of the bottom of the Laramie. For the next three miles and a half, the banks of the river are composed of vertical or highly inclined beds of olive or dark sandy or clay-shale, intercalated with beds of sandstone, the shales in the western part being more slaty than the others and containing well-preserved examples of *Baculites compressus*, which is a form highly characteristic of the Fox Hill and Pierre beds. This belt, therefore, doubtless is an area of much folded rocks of the groups above named, the harder overlying Laramie having been shoved upwards by the compressions, and afterwards denuded away, or left as high rocky ridges lying on the top of upturned edges of the shales. Finally, at the mouth of the north fork of Ghost River, the beds have again assumed more the character

Rocks
intricately
folded.

Rocks on
Ghost River.

Bands of
Pierre shales.

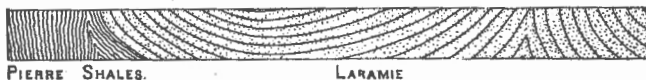
of sandstones with a high westerly dip, and immediately to the north, there is a high sandstone ridge, the harder beds of which project as naked rocky ledges through the generally grassy hill-side, each ledge, however, being bordered by a long row of scrub pines.

Following the outer edge of the foot-hills northward, or rather, in the general direction of the strike of the beds, we reach the Little Red Deer River, where it breaks through the most easterly ridge in a rocky defile, the sides of which, where trees can grow, are thickly covered with spruce. This ridge represents the top of the outer anticlinal of the disturbed belt, and from it the beds dip both to the east and to the west. It consists of vertical beds of grey sandy shale and sandstone of Laramie age, the fold not having been great enough to bring the lower formations to the surface. Ascending the stream to the mouth of Grease Creek, a distance of three miles and a half by the valley, these sandstones and sandy shales are seen dipping westerly with a constantly decreasing angle, till at the latter place they are apparently quite horizontal, the whole thickness of the beds here brought to the surface being considerably over 5,000 feet. It might be here noticed that Dr. Dawson, in his report on the region immediately to the south, gives the Laramie a minimum thickness of 5,750 feet.

West of the mouth of Grease Creek a high ridge runs N. 20° W. and S. 20° E., occupying the centre of a wide synclinal, and west of it the rocks, which consist of thick-bedded light-grey sandstones and light-greenish sandy shales, assume an easterly dip which becomes gradually steeper as the valley is ascended, till at a distance of two and a half miles above Grease Creek, and after another ridge of highly inclined sandstone is passed through, dark clay-shale holding lenticular nodules of ironstone is met with opposite a low longitudinal valley. For three-quarters of a mile up the river these dark-grey clay-shales crop out, interbedded with greyish sandstone, dipping N. 70° E. at an angle of 75°; they represent the irregularly folded beds of the Fox Hill and Pierre groups.

The following section represents the arrangement of the rocks on this river as far west as they have been worked out. :—

SECTION ON LITTLE RED DEER RIVER IN "FOOT-HILLS."



Horizontal scale 2 miles to 1 inch

Fallen Timber
Creek.

Towards the north, the next transverse valley reached is that of Fallen Timber Creek which, in its outer part is, however, wide and

swampy, and only in one place about the centre of range 6, was any exposure of the underlying rocks seen. They are here rather hard grey sandstones, forming a sharp anticlinal with a strike N. 20 W., doubtless a continuation of the outer anticlinal on Little Red Deer River. The flats on either side of the stream are underlain by a quartzite rubble which has been washed down from the Palæozoic rocks of the mountains and scattered over the bed of the constantly changing channel, the finer sand and gravel being washed out towards the plains. North of this creek the foot-hills are not so regular as to the south of it, and there are no continuous ridges east of the Stoney trail, as they have been irregularly denuded away and the country is left composed of detached and rounded hills.

The next river in order as we go north is the Red Deer, which is the Red Deer River—largest stream flowing from the mountains between the Bow and the North Saskatchewan.

At the crossing of the Stoney trail, much-folded beds of sandstone and sandy shale are exposed in the low banks of the channel, and along the valley, sandstone ridges run off N. 20° W., separated by low valleys representing doubtless shaly belts. The sandstone dips S. 40° W. < 60-70°. Two miles and a half below the bend, at the mouth of William's Creek, the rocks are still dipping in the same direction, but at the low angle of 15-20°. Again, a little above where the river runs out on Bearberry Prairie, sandstones and greenish sandy shales are seen in the hill back from the river, folded on each other several times, while in the bank of the channel similar sandstones and shales are seen in a vertical position, enclosing in some places, a thin bed of coal. About a mile and a quarter above the eastern side of the outer hill, the rocks consist of greenish-grey, rather hard sandstones and green or olive sandy shales, very much folded and broken, and half a mile further up still, similar rocks are met with, dipping N. 60° E. < 80° and enclosing a seam of coal, probably about nine feet thick, but so folded and slicken-sided, that it was impossible to measure it with any degree of accuracy. Specimens from this seam were analysed by Mr. Hoffmann, with the following result:—

Hygroscopic water.....	4.97
Volatile combustible matter.....	36.87
Fixed carbon.....	54.05
Ash.....	4.11
	<hr/>
	100.00

Coke non-coherent.

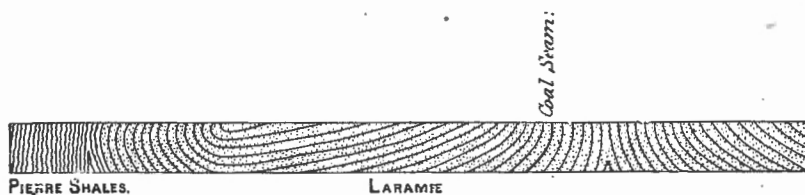
A bed of sandstone a few feet below the coal was found to contain, besides a cone of *Sequoia Nordenskiöldii*, impressions of leaves of *Platanus*.

nobilis and *Populus acerifolia*, all of which are plants characteristic of the upper division of the Laramie, and hence it is not improbable that this coal seam may be on the same horizon as the seam which crops out near Rocky Mountain House on the Saskatchewan. In a bed of sandstone a few yards from this place, a smoothly-rounded quartzite pebble an inch and a half in greatest diameter, was found, an interesting discovery, as it is one among a number of circumstances mentioned further on, which indicate proximity to the ancient coast line of the great Laramie lake or inland sea. East of this ridge the rocks gradually slope off to the plains so that we have here again the outer anticlinal of the foot-hills, probably a continuation northward of the same anticlinal which we saw on Little Red Deer and Fallen Timber Rivers, though in that case, its general strike is four to five degrees further west than was determined at any observed exposure, and, as on these two latter streams, there is here no indication that rocks older than the Laramie are brought to the surface.

Included
pebble.

The following section will serve to give a general idea of the rocks as seen on the part of the river just described:—

SECTION ON RED DEER RIVER IN "FOOT-HILLS."



Horizontal scale 2 miles to 1 inch.

North of the Red Deer, only a small area of foot-hills comes within the limit of the district comprised on the map, and it is, as yet, unexplored. Coal is reported to occur on James River, the North Saskatchewan, and the Brazeau, and when it is deemed advisable to have this disturbed country thoroughly examined, the results will, no doubt, well repay the trouble and expense incurred.

SYSTEMATIC GEOLOGY.

Under the head of Descriptive Geology, we have considered the rocks occurring in this district, as they were met with, in journeying through the country, either in the sides of the numerous valleys or in higher or lower escarpments rising above the general level of the plains. Under the present title, it is our purpose to present a short *résumé* of the character and distribution of the different series of strata, beginning with the oldest, and continuing upward to those most recently deposited. Table of deposits.

The following table, arranged in descending order, will serve to show the general character of the different groups or formations:—

POST-TERTIARY.		FEET.
Recent deposits.—Sands, clays and silts.....		...
Upper Boulder-clay.—Light-grey sand, and generally, indistinctly stratified clay, containing numerous pebbles of gneiss, quartzite, etc. ....		...
Lower Boulder-clay.—Dark-grey, thick-bedded, or massive, sandy clays containing pebbles of quartzite, etc., and numerous fragments of lignite.....		...
Pebble bed.—Quartzite shingle lying in a loose sandy matrix.....		...
MIOCENE.		
Gravels, fine sands and argillaceous marls, the gravels consisting of quartzite shingle, being sometimes cemented into a hard conglomerate by calcareous cement		270
LARAMIE.		
Paskapoo Series.—Grey and brownish-weathering, lamellar or massive sandstones, and olive sandy shales. This is an exclusively fresh-water deposit.....		5,700
Edmonton Series.—Soft whitish sandstones and white or grey, often arenaceous, clays, with bands and nodules of clay ironstone and numerous seams of lignite. These are of brackish water origin and correspond to the lowest portion of the St. Mary River series of Dr. Dawson's Report (Geol. Survey Report for 1882-84, p. 114 c.).....		700
FOX HILL and PIERRE.		
Brownish-weathering sandstones and dark-grey clay-shales.....		600
BELLY RIVER SERIES.		
Soft, whitish sandstones and arenaceous clays, changing towards the east to light-brownish and yellowish sandstones and sandy shales, bottom not seen .....		...

In the foot-hills, evidence was found of the presence of rocks of the age of the Benton shales, which immediately underlie the sandstones of

No unconformity below the Laramie.

the Belly River series, but our knowledge of them is, as yet, too imperfect to allow of our treating of them, in any way, and we can therefore simply record their occurrence.

No intrusive rocks occur anywhere throughout the district, and below the top of the Laramie there is no evidence of any unconformity between the different formations, although, in some cases, the extreme irregularity of the bedding gives the strata very much the appearance of having been laid down unconformably one on the other.

BELLY RIVER SERIES.

Character of rocks.

This series is represented by white or light-grey clays and soft clayey sandstones, interbedded with bands and nodules of clay iron-stone. These nodules are often highly calcareous, breaking with a smooth, sharp fracture. Towards the centre, on a freshly broken surface, they are of a clear slate-grey colour, around are darker and darker layers, till the outer one, which is very dark-brown, almost black.

Character of valleys in the white beds.

As has already been pointed out in the reports of Dr. Dawson and Mr. McConnell, this series, if followed toward the east, is found to lose gradually its clayey character, and to consist of purer and much more massive sandstones, generally of a yellowish colour. When the beds are white and clayey, it is possible to trace with comparative ease and accuracy the line of junction between it and the overlying Pierre shales, as in river valleys it almost everywhere presents white sandy escarpments to its very summit, above which the land rises gently to the level of the surrounding country, and wherever this rise is cut through by small creeks the rock is seen to be dark-grey Pierre shales. This is especially the case along the valley of Red Deer River between long. 111° and 112° W., a short distance south of the edge of the accompanying map, and also on Battle River for several miles below the Elbow.

Unfossiliferous character of beds.

Further east, however, where the beds become harder and much more sandy, the line between these two formations becomes much more difficult to trace out, as there is little or no difference between these sandstones and those with the character of the Fox Hill group, which are interbedded, almost everywhere, with the shales of the Pierre, though typical Fox Hill fossils are generally found in these in considerable abundance, while in the yellow sandstones that underlie the shales, no fossils of any kind have ever been found within this district. Even in the white beds further west, very few fragments of fossil mollusca were found, and these belonged to essentially fresh-water genera such as *Unio*, *Sphaerium*, etc.

Remains of plants are, however, comparatively common, and generally in the form of fragments of wood presenting every grade of preservation between pieces that are seen merely as obscure markings in the coarse sandstone, and those which are perfectly silicified and shew all the structure of the original woody tissue. Fragments of leaves were also occasionally met with, from among specimens of which were identified *Trapa borealis*, Heer, *Salisburia*, sp., and *Podocarpites Tyrrellii*, Dawson. Beside these, Sir Wm. Dawson has identified the following genera of fossil woods from among specimens brought from Ribstone Creek: *—*Sequoia* of the types of *gigantea* and *sempervirens*; *Thuja* of the type of *occidentalis*; *Betula* and *Platanus*. The three former have been found in other localities in the Belly River series, while the first of the *Sequoias* and *Betula* are also known from the Pierre shales. Plant remains common.

On account of the extreme paucity of sections, it has been impossible in most cases, to determine the precise confines of this series, though enough is known to enable us to fix its general outline as it is laid down on the map. Its northern limit is the part most doubtful, and it is not at all impossible that instead of dipping under and disappearing altogether near the north-west bend of Vermilion River, it merely narrows very much here or perhaps disappears under the overlying Pierre for a short distance and reappears at the north-west angle of the North Saskatchewan, where a range of white sandstone cliffs occupies the southern bank for several miles. In this case, the Pierre shales must cross the valley of the North Saskatchewan in the vicinity of the mouth of Beaver Creek, and as there is very little evidence as yet forthcoming on that point, we have deemed it advisable to consider that the sandstones, at the above mentioned place, belong to the lower part of the Laramie series. Boundaries of the formation.

No workable coal seams have been found in this series, though a thin seam crops out near a small lake in Buffalo Coulee. No coal.

FOX HILL AND PIERRE GROUP.

This group consists of dark or light-grey, very friable clay shales, weathering down into a soft tenaceous clay; interbedded with bands of coarse-grained yellow sandstone. Unlike the beds both above and below it is of purely marine origin, having been laid down in a sea of varying, though generally very considerable depth. Character of rocks.

The thickness of the formation, wherever it could be measured, was Low anticlinal.

* Note on Fossil Woods and other Plant Remains, from the Cretaceous and Laramie Formations of the Western Territory of Canada, by Sir William Dawson, F.R.S. Trans. Roy. Soc. Canada, 1887, Sect. IV., p. 31.

found to be from six to seven hundred feet. In the eastern portion of the district, it lies in a very low anticlinal, with a strike of N 30° W, the top of which has been denuded away, leaving the sandstones and clays of the Belly river series at the surface, while further west it disappears under the sandstones of the Laramie, and is not seen again till the foot-hills are reached, where its strata either are vertical or dip at a high angle to the west or east, being often folded backwards and forwards in a very complicated manner, the overlying beds having been squeezed out and removed by denudation.

Fox Hill and
Pierre insepar-
able.

It is quite impossible here to separate the Fox Hill sandstone from the Pierre shales, as they are completely interbedded from the top to the bottom of the group. In descending Battle River, this is particularly noticeable, as at the top of the group, yellow sandstones are met with containing *Placenticeras placenta*, *Teredo* burrows, etc., and at the bottom a sandstone quite indistinguishable from that above is seen holding precisely the same fossils. In the southern part of the district, nodules of clay ironstone are common throughout the shale, and fossils are plentiful, both in the nodules and in thin bands of included sandstone, but to the northward, fossils become much more rare and new species begin to appear, which are not known to the south.

List of fossils.

The fossils found in the district up to the present are:—

Ostrea sp.

Pteria linguiformis, Evans and Shumard, var. *subgibbosa*, Meek.

Inoceramus Sagensis, var. *Nebrascensis*, Owen.

Inoceramus Vanuxemi, Meek and Hayden.

Gervillia recta, var. *borealis*, Whiteaves.

Modiola sp.

Lucina occidentalis, Morton.

Tancredia Americana, Meek and Hayden.

Cyprina ovata, Meek and Hayden.

Cyprina subtrapeziformis, n. sp.

Astarte sp.

Protocardia subquadrata, Evans and Shumard.

Protocardia borealis, Whiteaves.

Linearia formosa? Meek and Hayden.

Pholadomya subventricosa, Meek and Hayden.

Periploma, sp.

Liopistha undata, Meek and Hayden.

Panopæa subovalis, n. sp.

Solecurtus (Tagelus) occidentalis, n. sp.

Martesia tumidifrons, n. sp.

Teredo or *Turnus* burrows.

Hydatina parvula, n. sp.

Anisomyon, fragment.

Lunatia concinna, Hall and Meek.

Baculites ovatus, Say.

Baculites grandis, Hall and Meek.

Baculites compressus, Say.

Scaphites nodosus, Owen.

Placenticeras placenta, Dekay, var. *intercalare*, Meek.

Palæastacus ornatus n. sp.

Pectoral of a Selachian.

Abietites Tyrrellii, Dawson.

No workable beds of coal occur in this group within the district, though in the shales on the top of the high ridge to the north of the Neutral Hills, a thin band of carbonaceous shale is seen over a considerable area, and at Egg Creek, near the North Saskatchewan, there is a thin seam of coal of fine quality. No workable beds of coal.

The rocks of this group on the plains are either perfectly level or dip a few feet to the mile in a south-westerly or north-easterly direction, but in the vicinity of the mountains, they have been very much disturbed, and we find sandstones and shales folded into each other in a very complicated manner.

The distribution of this group throughout other parts of Manitoba and the North-West, has already been worked out with considerable accuracy by other members of this Survey from long. 106° to the base of the mountains as far north as lat. 51°. It extends eastward, roughly speaking, as far as the edge of the Pembina escarpment. To the northward it is represented by the shales found by Dr. Bell on the Athabasca River, below the mouth of Biche River,* and in the Peace River region by Dr. Dawson's "Upper Shales" or "Smoky River group," which there have a thickness of three hundred and fifty feet.† Extent beyond the limits of the district.

EDMONTON SERIES.

This is perhaps, on the whole, the most characteristic series of the entire region, for though its thickness, wherever determinable, was never found to exceed seven hundred feet, the horizontal position of the strata causes it to underlie a very large extent of country.

It consists generally of whitish or light-grey clay and soft clayey sandstone, weathering very rapidly with more or less rounded outlines. In some places, as on Red Deer River and in the Hand Character of the rock.

* Geol. Survey Report for 1882-84, p. 8 cc.

† Geol. Survey Report for 1879-80, p. 122 B. etc.

Hills, it is seamed with a great number of beds of ironstone, which with thin beds of lignite and lignitic shale, give a definite banded character to all the escarpments. It also contains a great number of nodules of compact ironstone, which are often perched on little pinacles cut out of the soft sandstone. In the northern portion especially along the North Saskatchewan, the banded appearance is seldom seen, though, with the exception of a smaller quantity of ironstone, the rock has very much the same character as further south.

Coal-bearing
horizon.

This is essentially the coal-bearing horizon within the district, all the coal found east of the foot-hills, except probably the seams on the Upper North Saskatchewan and at Egg Creek, being of this age. The top of the formation is marked by an extensive coal deposit, seen first in the Wintering Hills as a thin bed of carbonaceous shale, but on being traced northward is found to thicken very greatly, till on the North Saskatchewan, near Goose Encampment, it has a thickness of twenty-five feet. The bottom of the series lies conformably on the Pierre shales, without any sharp line of demarcation between the two. In fact, the shales gradually lose their massive character, and change almost insensibly into thin beds, which are of decidedly brackish-water origin. In the Pierre, remains of land plants and animals are very rare, while here traces of land plants become fairly plentiful, and on Red Deer River, Dinosaurian bones are met with in great abundance, showing, with the presence of estuarine shells, the partly land-locked character of the area within which the beds were deposited.

List of fossils.

Besides the fragments of teeth and bones of Dinosaurs that Prof. Cope has kindly undertaken to determine, the following fossils were found in this formation within the district:—

Ostrea glabra, Meek and Hayden.

Unio Danæ, Meek and Hayden.

Corbicula occidentalis, Meek and Hayden.

Panopæa simulatrix, Whiteaves.

Panopæa curta, Whiteaves.

Trapa borealis, Heer.

Salisburya, sp.

Carpolithes, sp.

Fragments of exogenous leaves and woods of *Sequoia* of the types of *gigantea* and *sempervirens*, and a species of *Thuja*.

Extent on the
North
Saskatchewan.

As will be seen by reference to the map, this series underlies a considerable belt of country extending, on the North Saskatchewan, from the outcrop of the "Big Coal Seam" to or a little beyond its easterly

bend north of the Beaver Hills; and it stretches a little south of east to Red Deer River in the vicinity of the Hand Hills, comprising the lower part of the bold escarpment which there forms the south-western boundary of these hills.

To the west, this series gradually disappears under the overlying beds of the Paskapoo series, and in the foot-hills no sign of its presence could be detected, although, in many places, the junction of the Pierre and Laramie was clearly seen, the sandstones of the Paskapoo series appearing to rest conformably on the shales of the Pierre, so that the Edmonton series seems to thin out and disappear between its western outcrop and the eastern edge of the foot-hills.

Outside the area embraced in the present map, these beds have been already mentioned and described by Dr. Dawson* as outcropping on the Old Man, Little Bow and Bow rivers, and forming a brackish-water transition series between the overlying Laramie and the Pierre; and by Mr. McConnell in the Cypress Hills region, who calls them the lower division of the Laramie, and writes of them as follows:—†“The lower one (division), which succeeds the Fox Hill conformably wherever the contact plane of the two formations was observed, bears a strong resemblance to the upper part of the Belly River series, and consists of about 150 feet of feebly coherent greyish and pure white clays, sandy clays, and sands, with occasional beds of carbonaceous shales and lignite. A small bed of black clay was also found to be pretty widely distributed. The beds of pure white sands and clays form the most distinctive feature of this band, and were observed, with few exceptions, wherever the base of the formation was exposed. In the bad lands south of Wood Mountain this division consists almost exclusively of clay.”

Extent, beyond
the limits of
the district.

Now, turning northward to the Peace River region, this series is easily recognized in Dr. Dawson's Wapiti River group, which, on the lower part of the Wapiti River and on Smoky River, overlies the Pierre shales with a thickness of two hundred feet or more.‡ Dr. Dawson also recognized the Wapiti River group on the upper portion of the Athabasca River,§ though it is probable that the rocks seen above the outcrop of the ten-feet coal seam belong to the next overlying series. Beds belonging to the lower part of the Laramie, and perhaps of the age of this series, were found by Dr. Dawson in the Rocky Mountains, near the headwaters of Old Man and Highwood rivers, folded in with older Mesozoic and Palæozoic rocks.

* Geol. Survey Report for 1882-84, p. 114 c.

† Geol. Survey Report for 1885, p. 67 c.

‡ Geol. Survey Report for 1879-80, p. 124 b.

§ Loc. cit., p. 126 b.

|| Geol. Survey Report for 1885, pp. 89 and 92 b.

Presence of
gold reefs of
this formation.

The occurrence of gold in the rocks of the upper part of this series is an interesting fact brought to light by the analyses mentioned on page 109 E. It would seem from these analyses that gold is scattered in small quantities through the rocks of the Edmonton Series in the vicinity of the "Big Coal Seam" on the North Saskatchewan, and as it is found on the bars in the river in paying quantities as far east as this series of rocks extends, it is not improbable that gold may be found sparsely scattered through these sandstones and clays, or even through any of the underlying formations. The river annually washes a large quantity of these soft rocks from its banks, and separates the gold, which settles with the heavier sand and gravel on the bars running out into the stream, while the finer material is carried further east and continues to whiten the water as far as Cedar Lake.

Miners assert that the coarsest gold is found in the neighborhood of the above mentioned coal seam, and that it becomes finer as they go down the river.

Gold not
derived from
Rocky Moun-
tains.

Dr. Selwyn recognized the fact that the gold in the Saskatchewan was not derived from the mountains at its source, but rather was washed out of the soft rocks which form its banks, after it leaves the harder strata of the mountains; and he considered that it was disseminated throughout the "drifts composed of granitoid gneiss, with hornblende and micaceous schist, quartz and limestone, which are spread over the face of the country for hundreds of miles and which must have been themselves largely derived from the denudation of the great belt of Laurentian and other crystalline rocks, which extend from the shores of Lake Superior north-westerly to the Arctic Sea." (l. c., p. 58.) It is not improbable that some gold is derived from the overlying drift; but some is certainly, as above stated, derived from the underlying rocks of the Edmonton Series, especially about the horizon of this coal seam which forms their upper boundary.

The question of the source from which the gold was originally derived therefore involves that of the materials which form the sandstones and clays of this series, but the information at hand for the determination of that point is very small.

Sandstone
probably
derived from
area of grani-
toid rocks.

It will be seen by reference to page 132 E that this series is considered to be of brackish water origin, and that the position of the western shore-line of the sea in which it was deposited lay but a short distance beyond the western limit of its present outcrop, while the sea itself stretched far out towards the north, the east and the south. As much of the material of which these rocks is composed is a coarse heavy sand that would not readily have been carried from one shore to another by ocean-currents, it seems more reasonable to suppose that it was derived from the wear of the adjacent coast-line, or rather, as the

coast was in all probability skirted by a wide belt of marsh, was brought down from the high lands in the interior by rapid streams that poured their waters, laden with detrital material, into this shallow sea. At present the Rocky Mountains occupy a position just west of, or in some places overlapping this ancient shore-line, but the results of the examinations of the mountains lately carried on by Dr. Dawson and others have shown no reason to suppose that they were then at all folded, but rather seem to indicate that they were merely a comparatively undisturbed land area through which rivers might flow to the nearest ocean. Lime is present in large quantity in the rocks of the Edmonton Series, and it was probably derived from the Devonian and Carboniferous limestones which doubtless came to the surface over part at least of the above area, an area of course very much larger than that now occupied by the Rocky Mountains, but the materials of which the sandstones are composed are not such as could have been derived from these overlying limestones or even from the underlying quartzites and slates, but consist largely of felspar, with some quartz, mica, and a decomposed ferruginous mineral, probably magnetite, or such as might be expected to be derived from the degradation of granitoid rocks.

A wide belt of such rocks exists in the present Selkirk or Gold range, just west of the Rocky Mountains. It would seem not improbable, therefore, that rivers rose in this range and flowed eastward across the intervening land area into the sea in which the Edmonton Series was being deposited, carrying with them the sand derived from the rock over which they flowed in the upper part of their courses, and with this sand would be mingled a large quantity of calcareous material washed from the sedimentary palæozoic beds composing the banks in their stretches.

In this case the gold found in the North Saskatchewan would have been originally derived from the wearing down of the gneisses and granites of the Selkirk Mountains, from which numerous small streams are still carrying gold into the wide valleys that run along their eastern and western sides.

PASKAPOO SERIES.

Under this heading we group all the Laramie rocks lying above those of the Edmonton series; thus it will include Dr. Dawson's Porcupine Hills and Willow Creek series, and all but the lowest 700-900 feet of his St. Mary river series. On the plains, no place was seen where its total thickness could be measured, but at the outer edge of the foot-hills, on Little Red Deer River, a thickness of 5,700 feet at least was determined, the bottom of the formation

Gold derived
from Selkirk
Mountains.

Thickness
of series.

not being seen, and it is probable that a considerable thickness had been denuded from the top.

Character of
the formation.

The beds consist of more or less hard, light-grey or yellowish, brownish-weathering sandstone, usually thick-bedded, but often showing false bedding; also of light bluish-grey and olive sandy shales, often interstratified with bands of hard lamellar ferruginous sandstone, and sometimes with bands of concretionary blue limestone, which burns into an excellent lime. The sandstones consist of very irregular, though slightly rounded, grains of quartz, felspar, and mica, cemented together in a calcareo-argillaceous matrix.

List of fossils.

The whole series, as shewn by its invertebrate fauna, is of fresh water origin. In this district the following fossils have been found in it:—

- Unio Danae*, Meek and Hayden.
- Sphaerium formosum*, var.
- Limnæa tenuicostata*, Meek and Hayden.
- Physa Copei*, White.
- Acroloxus radiatulus*, Whiteaves.
- Thaumastus limnæiformis*, Meek and Hayden.
- Goniobasis tenuicarinata*, Meek and Hayden.
- Hydrobia*, sp.
- Campeloma producta*, White.
- Viviparus Leai*, Meek and Hayden.
- Valvata filosa*, Whiteaves.
- Valvata bicincta*, Whiteaves.

Of fossil plants the following have been found:—

- Onoclea sensibilis*, Linn.
- Sequoia Nordenskiöldii*, Heer.
- Sequoia Langsdorfii*, Heer.
- Sequoia Couttriae*, Heer.
- Taxodium occidentale*, Newberry.
- Platanus nobilis*, Newberry.
- Corylus McQuarrii*, Heer.
- Quercus*, sp.
- Populus acerifolia*, Newberry.
- Populus Richardsoni*? Heer.
- Populus arctica*, Heer.
- Ficus*, sp.
- Salix Laramiana*, Dawson.
- Viburnum asperum*, Newberry.
- Viburnum Saskatchewanense*, Dawson.
- Catalpa crassifolia*, Newberry.
- Sapindus*, sp.

Carya antiquorum, Newberry.

Juglans, sp.

Nelumbium Saskatchewanense, Dawson.

Within the district north-east from the edge of the disturbed region, ^{Extent of the formation.} this series occupies a belt seventy to a hundred miles wide, and in the foot-hills themselves, it constitutes entirely the outer anticlinal, and within that, it is folded in with the Pierre and older beds. Outside the district it has been traced along with the Edmonton series as the Laramie or Lignite Tertiary formation, by Drs. Richardson, Selwyn, Dawson and Bell, southward to the Boundary Line, eastward to the Turtle Mountain in Manitoba, and northward to the Arctic Circle in the valley of the Mackenzie.

In reference to the age of the Laramie, including its two subdivisions, ^{Age of Laramie} some interesting discoveries have been made. In ascending from the Pierre group, which is clearly of Upper Cretaceous age, we pass gradually from beds of purely marine origin to the Edmonton series, which was laid down in shallow brackish water in an almost land-locked bay, or in a great salt marsh near the mouth of a large river. This is shown by the presence of numerous beds of coal, of many fragments of land plants and leaves, of brackish-water molluscs, and great numbers of bones of land Dinosaurs, which have evidently been entombed in the beds over which they waded or in the marsh on or along the edge of which they used to feed or hunt their prey.

The shore line that bounded towards the west this shallow water or ^{Shore line of Edmonton sea.} marsh ran between the present western outcrop of the Edmonton series and the position of the foot-hills, though further south, according to Dr. Dawson, these beds extend through the present position of the foot-hills into the mountains, which were, however, not then upraised; but in the district under consideration, the region of the foot-hills was raised slightly above the sea level, though not to such an extent as to suffer any appreciable amount of erosion, and was, doubtless, cut through by rivers that brought down sediment from the higher land to the west, and spread it out over the marshes near the shore as stated on a previous page.

At the close of the Edmonton period, the pressure which had caused <sup>Mountains up-
lifted at close
of Edmonton
period.</sup> the uprising of the present plains-area from the bottom of the Pierre sea, and which towards the west had raised the land completely above the surface of the water, was relieved by the uplifting of the Rocky Mountains along a line near the western edge of this great area, and the "Plains" sank again beneath the surface of the sea, now cut off entirely from the main ocean and converted into a great inland lake, and a thickness of several thousand feet of sandstones and sandy shales,

was laid down on the gradually sinking floor, these sandstones and shales being the Paskapoo series of this report. In these beds, no Dinosaurian remains have been discovered, but we find in them a considerable number of land plants, and land and fresh-water molluscs, with occasionally beds of coal.

Period of
elevation at
close of
Laramie.

At the close of the Laramie, another period of elevation was ushered in; the foot-hills were folded into something like their present condition, and a great thickness of the Laramie was denuded before the Miocene of the Hand Hills was deposited on it.

Cretaceous
closes with
Edmonton
series.

Judging, therefore, from the facts that the Edmonton series is composed of but from 600 to 700 feet of sands and clays, which have been rapidly deposited conformably on the top of shales of Upper Cretaceous age; that the flora and invertebrate fauna of this period are very similar to those of the Belly River series, which distinctly underlies the Pierre; that, at the same time, Cretaceous types of Dinosaurs continued to flourish; that, at the end of this period, these latter forms died out, and a time of great disturbance ensued, in which the Rocky Mountains were uplifted, it seems reasonable to place the close of the Cretaceous Epoch at the time of deposition of the topmost beds of the Edmonton series; and that the Tertiary Epoch began with the commencement of the Paskapoo period, during which a great thickness of sandstones and sandy shales was laid down without any apparent break or unconformity. In this Paskapoo series then, we have the representative of the Eocene of Europe.

MIocene.

Composition.

Resting on the denuded edges of the Laramie in the Hand Hills, are beds of light-grey argillaceous marls interbedded with fine-grained sands, which pass upwards into a bed of quartzite pebbles, in some places held together by a hard calcareous cement, and forming a compact conglomerate. On the west side of the hills this stands out boldly at the top of the escarpment, giving the impression when seen from a distance, of a horizontal band of hard sandstone.

These rocks have already been referred to on page 78 E in describing the geology of the Hand Hills.

No fossils.

Though fossils were carefully searched for throughout the formation, none were found, but there is little doubt, considering its position and character that it is of the same age as the Miocene of the Cypress Hills, which was first examined by Dr. Hector, in the summer of 1859, and briefly described by him,* though its exact age, thick-

*Journals, Detailed Reports, and Observations, relating to the Exploration by Capt. Palliser. London, Government, p, 221, and Q. J. G. S., Vol. XVII. p 399.

ness and distribution, was not known till the Cypress Hills were visited by Mr. McConnell, in 1884.

POST-TERTIARY.

Overlying the greater part of the area examined, is an extensive, though generally thin, sheet of superficial sands, clays and gravel, which fill in and level up many of the irregularities in the surface of the Cretaceous and Laramie rocks, though, as in the case of many of the rolling hills, they have also served to add to the surface irregularities.

In the district to the south, Dr. Dawson has divided these deposits into several fairly distinct sub-divisions, and as these can, in many cases, be also distinguished in the area under consideration, his table is here given : *

"Stratified sands, gravels and silts.
Upper boulder-clay.
Interglacial deposit with peat.
Lower boulder-clay.
Quartzite shingle and associated beds."

Divisions of
superficial
deposits.

The quartzite shingle consists of a deposit from two to twenty feet in thickness of well-rounded, water-worn quartzite pebbles, about the size of small cobblestones, imbedded in a matrix of soft sand. This pebble bed rests everywhere immediately on the surface of the underlying Laramie, having been deposited at various elevations in lake or river beds in the epoch immediately preceding that in which the country was buried under a great continental glacier or glacial sea. The distribution of the quartzite shingle has already been traced and described by Dr. Dawson from near the mouth of St. Mary River to the Bow River, at the mouth of the Highwood, and it remains here to describe it northward to the North Saskatchewan.

On the Little Red Deer River it was first seen a short distance below the mouth of Dog Pound Creek, where a thickness of fifteen feet underlies the boulder-clay at an elevation above the sea of 3,300 feet. On Red Deer River, gravel terraces and flats are common in the upper part of its course, but these were not seen to be overlain by boulder-clay till a bank a short distance below the crossing of the Rocky Mountain House trail was reached at an elevation of 3,150 feet. Here the pebble bed rests immediately on the sandstones of the Laramie, and is overlain by the bottom beds of the boulder-clay, as shown in the following section :

* Geol. Survey Report for 1882-84, p. 140 c.

	FEET.
Light-coloured, roughly stratified sandy clay with numerous pebbles	5
Stratified sand becoming slightly clayey towards the top and containing a few pebbles	7
Rather hard dark-coloured unstratified boulder-clay containing pebbles of quartzite, sandstone and coal, but none of gneiss	17
Bed of quartzite pebbles, with soft sandy matrix, unstratified, except that the pebbles are lying with their greater axes horizontal. The line between this bed and the one above it is very sharp.....	20
Sandy shales and sandstones.....	8
	<hr/> 57

Below the above point, the pebble bed is seen almost constantly in the banks of the river to a short distance below the mouth of the Blind Man, where it is cut off by a ridge of Laramie hills, through which the river has worn a steep narrow gorge. All the sections seen are essentially the same as that given above.

In the valley of the North Saskatchewan River, the pebble bed is seen at an elevation of 3,000 feet, a few miles above the mouth of Baptiste River, overlain by boulder-clay, and again, a short distance below Edmonton, a similar quartzite pebble bed eight feet in thickness overlies rocks of the Edmonton series and merges above into stratified sand, forming in all a bed twenty feet in thickness. This again is overlain by dark columnar boulder-clay, the lower edge of which is sharply defined against the stratified sand below.

On Battle River

On Battle River, gravel, apparently also of this age, underlies the level country west of Todd's Crossing, being here generally overlain by the more stratified upper portion of the boulder-clay, though the lower columnar part is also seen in some places. At one point a short distance south of where Battle River flows into the wide valley of Pipestone Creek, a bed of gravel twelve feet thick, in which, however, there appears to be a slight admixture of small pebbles of gneiss, underlies the boulder-clay, and generally rests on the surface of the Laramie, but in one place, as stated on page 85 E, the otherwise horizontal surface of the Laramie is hollowed out for a depth of about our feet, and the depression is filled with large boulders of gneiss and quartzite, mingled with nodules of clay ironstone.

Origin of the gravel deposits.

It is probable that the material of the gravel seen in the upper parts of the streams, nearer the mountains, is derived directly from the Palæozoic quartzites in the Rocky Mountains, and it is also probable that all the material of the quartzite pebble beds on the plains were originally derived from the same source, but in the case of the

shingle beds near Edmonton as well as of those on Battle River, it would seem that their material has been immediately derived from some areas of older conglomerate, perhaps of Miocene age, that formerly covered the top of the Beaver Hills, but have long since been denuded and redistributed over the less elevated country. The gneissoid boulders, however, that are seen to underlie the shingle near Battle River must have been brought from the north or north-east by a stream that flowed southward from the Archæan continental nucleus. This would be quite in accord with the theory of the southern elevation of the continent in the Post-Pleiocene times, a theory for which many other and independent proofs have been advanced.

In the Battle River valley, near the mouth of Iron Creek, a thick deposit of quartzite gravel of more recent date underlies a considerable area. It has doubtless been derived from some beds of older conglomerate that probably covered the country in the vicinity of Flagstaff Hill. Deposit at
mouth of Iron
Creek.

Resting on the surface of all the older strata, including the pebble-bed just described, the boulder-clay covers a great part of the district east of the foot-hills. Towards the west it is generally divisible into two fairly distinct portions, while further east, the characters that distinguish the two subdivisions do not obtain, and at present it must be considered simply as one deposit. Nowhere throughout the district, however, is this boulder-clay deposit known to be of any great thickness; it would not average more than from twenty to thirty feet, while in many places it has been entirely denuded, leaving the Laramie and Pierre clays close to the surface or covered only with a few feet of earth derived from the disintegration of the underlying beds. But the valleys cut by most of the streams are so shallow, and the banks are so sloping, that very often there is no sign of the underlying rocks. Boulder clay.

This boulder-clay is composed of a more or less sandy clay generally firmly compacted together, and holding pebbles and boulders which in the western portion are largely composed of quartzite, though some of gneiss are almost always present, but further out on the plains the percentage of quartzite pebbles becomes very much reduced, and pebbles of sandstone become comparatively numerous; almost everywhere, too, fragments of lignite derived from the underlying rocks are present. Composition of
boulder-clay.

The deposit is generally massive in character, but often, in its upper portion, shows indistinct signs of stratification, while the lower portion is intersected by numerous jointage planes, so that where a bank is being rapidly washed away it presents an almost perpendicular face, with a roughly columnar, rather than an even surface. Physical
character.

The prevailing colour is a bluish or yellowish grey, but the lower beds are generally much darker from the presence of fragments of coal as mentioned above.

The larger streams almost everywhere cut through this boulder deposit, the only exception being the North Saskatchewan, near the mouth of Beaver Creek, where the banks are less than a hundred feet high, and Rosebud Creek, about the middle of its course, where the banks have a height of eighty feet.

Western limit. The western limit of the boulder-clay appears to coincide closely with that of the underlying quartzite gravel, but this is doubtless either because the gravel has been washed away when not protected by a covering of clay, or because we have not been able to separate the recent from the more ancient gravel beds, where the overlying glacial deposits are absent. This western limit follows roughly the 3000 feet contour line, rising, however, towards the south three or four hundred feet above it.

On Little Red Deer River. In descending Little Red Deer River, boulder-clay is first seen near the mouth of Dog Pound Creek, where it overlies the pebble bed with a thickness of twelve feet, while on the latter creek, it crops out along the sides of the wide sloping valley for several miles above its mouth.

On Red Deer River. On Red Deer River, the first section observed was that given on page 138 E, where the drift exhibits the typical characters of the upper and lower subdivisions, separated by a bed of stratified sand. Near the mouth of Blind Man River, the uppermost subdivision of the superficial deposits is exposed, as a band ten feet thick, of light-grey, rather hard, stratified silt, immediately overlying the dark-coloured lower boulder-clay, and forming a projecting ledge, the line between these two latter beds, however, not being sharply defined. Towards the northwest, near the head waters of the Blind Man and Medicine rivers, dark-grey sandy boulder-clay covers the surface, while on the other side of the watershed, near the source of Wolf Creek, similar clay with included gneissoid boulders, forms in places the bank of the stream.

On North Saskatchewan River. On the North Saskatchewan many gneissoid boulders are scattered along the bed of the river as far up as the mouth of Baptiste River, and to a short distance beyond it, where the following section was observed in the sloping bank:—

	F.E.E.T.
Light-grey bedded clay.....	8
Covered	30
Dark-coloured jointed sandy clay containing pebbles of coal, quartzite, gneiss, etc.....	6
Bed of quartzite pebbles.....	14
Lamellar light-grey sandstone	2

East and north of the line thus roughly outlined by the above exposures, the boulder-clay covers the country more or less continuously, the Hand Hills being the only area on which it appears never to have been deposited. Its thickness is, however, very unequal, being much greater in the pre-glacial hollows in the Cretaceous and Laramie rocks, than on the tops of the hills that had been formed when these underlying rocks were being worn down to their present level.

The stratified sands and silts overlying the true boulder-clays have also played a very important part in filling up ancient depressions. As the front of the great continental glacier receded towards the north, or when the water was retiring at the close of the glacial epoch, large lakes filled the depressions in the uneven surface of the country, and into these lakes the drainage of the surrounding land was carried, and its included sediment settled to the bottom forming beds of fine stratified sand and clay. Similar beds must be forming now on a small scale in the little lake at the bend of Battle River, between Todd's Crossing and the "Leavings," as the river flows into it loaded with sediment, but leaves it beautifully clear, having dropped all its mud among the weeds in the shallow lake. Beds of this character are well seen on Red Deer River, near the crossing of the Calgary-Edmonton trail, and on Rosebud Creek, about the middle of its course. On the latter stream, the following interesting sections were observed:—

	FEET. INCHES.		
Banded and almost shaly light-grey clay.....	15	0	Lignite in boulder-clay.
Compact clay.....	12	0	
Sandy clay with boulders.....	15	0	
Pure stratified sand.....	40	0	
	82	0	

And at a short distance further east:—

Bedded shaly clay, at the top.....		
Sandy boulder-clay	20	0
Irregular seam of lignite.....	0	1
Whitish sandy boulder-clay with a few small pebbles, and a thin seam of ironstone	4	0
Clayey sandstone.....	8	0
	32	1

This is the only place in this district where a seam of lignite was noticed in the boulder-clay, though Dr. Dawson has recorded it from several places in the region to the south.

A short distance below Edmonton, on the North Saskatchewan, some very interesting sections of the superficial deposits have also been seen. Irregular drift on North Saskatchewan River.

From Edmonton to the mouth of Sturgeon River, from fifteen to twenty-five feet of columnar dark-coloured sandy drift occupies the top of the bank, underlain by about twenty-five feet of stratified sand and gravel. At the mouth of Beaver Creek, the banks of the North Saskatchewan are seventy feet in height; they are composed of yellow sand and are interbedded with blue shaly clay containing pebbles of gneiss, quartzite, ironstone, etc., while the top is a sandy clay containing large gneissoid boulders. These sands and clays are newer than the true boulder-clays, being composed of material largely derived from them; they are probably of the same age as the bedded clays, and not improbably also as those of the older drainage channels shortly to be described.

Irregular
"rolling"
hills.

On the Plains east of the 113th meridian, the surface is generally covered with a few feet of drift, but this deposit is not known to be anywhere of any very great thickness, as most of the streams have cut through it into the underlying rocks. Over considerable areas, however, it has been piled up very irregularly; for instance, in the Neutral Hills it has played an important part in giving the country its present hilly aspect. The same may also be said of the Blackfoot Hills; and the Beaver Hills are simply rounded drift knolls that have been laid down on an elevated ridge of the underlying Laramie rocks, or against the edge of a plateau that has since been washed away.

On the southern and eastern sides of the Hand Hills, on the south side of the Wintering Hills, and in a few other places, the drift assumes the form of round-topped hills, sometimes as much as two hundred feet high, with a roughly circular contour, separated by deep grassy depressions in the bottom of which lie little fresh-water lakes, none of which have any outlet. Very few sections were seen in these hills, but those which were seen showed boulder-clay similar to that overlying the more level parts of the country.

Sand hills.

Considerable areas are also covered with loose yellow sand, either as drifting sand hills such as those lying south of Rosebud Creek, south of Battle River near the mouth of Ribstone Creek, and the low sandy ridges that run across the plains near the head of Sounding Creek; or as more consolidated sand, such as that of the wooded hills north of the Neutral Hills, and over a considerable stretch of country still further north. The Beaver Hills are also overlain by a sandy covering derived, doubtless, from the disintegration of the underlying drift; and on Clearwater River and Prairie Creek, towards the foothills, long ridges of coarse yellow sand, covered with cypress and juniper, run parallel with their eastern edge.

Distribution of
boulders.

Wherever the boulder-clay comes to the surface, and on many of the higher ridges on which it has been in all probability but thinly depo-

sited, and has since been washed away, large and small boulders of gneiss, doubtless of eastern origin, cover the surface. On the plains, these boulders are collected and exposed in great numbers around the edges of lakes, as well as on the summits of all the higher elevations. This is especially the case on the Neutral Hills, the summits of which, and, in fact, of all the surrounding higher lands, are covered with a great profusion of boulders of gneiss and limestone, while on the sides of the hills there are many small pebbles of chert. Either these hills were formed in the glacial sea in shallow-water where numbers of icebergs stranded and dropped their load of pebbles and boulders to the bottom, to be afterwards rounded by atmospheric agencies when the country rose above the level of the water; or the stratum of boulder-clay or till that was deposited by the continental glacier, has had the greater part of its finer sediment washed down to a lower level, leaving the large boulders on the tops of the hills. On the summit of Blackfoot Hills a few gneissoid boulders are scattered, but on Beaver Hills very few boulders are seen except around the lakes as they have probably been buried under the many beaver meadows which fill most of the valleys. Gneissoid boulders are also numerous on the top of Medicine Lodge Hills at an elevation of 3,415 feet, on the ridge east of the crossing of the western Wolf Creek, and on the sides of the ridge at the head of the west branch of Medicine River at an elevation of about 3,200 feet. Mr. Hamilton, my assistant, in 1885, stated that he found a gneissic boulder also at about the latter elevation on the trail leading southward from Rocky Mountain House.

The top of the Hand Hills shows no signs of glaciation, but at an elevation of about 3,200 feet, the surface begins to break into rolling hills, which represent either the shore line of the glacial sea or a morainic deposit along the edge of the great glacier. The country around the foot of the hills, as well as around the Wintering Hills, is thickly strewn with quartzite pebbles, evidently derived from the Miocene conglomerates that now cap the Hand Hills and may formerly have also overlain the Wintering Hills.

Terraces are seen on the upper parts of all the principal streams and on the North Saskatchewan throughout the greater part of its course down to Fort Pitt, as well as in some of the old drainage channels that intersect the country, notably in that down which the Vermilion River now flows. These old channels, the principal of which have been enumerated on a former page of this report, have, in the period immediately succeeding the Glacial epoch, carried large streams in an eastward or south-eastward direction from the mountains or their vicinity. Now their banks are sloping and grassy and they are drained by very small streams, or their bottoms are occupied by narrow

Unglaciated
tract on
Hand Hills.

Ancient river
channels.

lakes. Where these old channels connect with those in which large rivers at present flow, the streams, in every case, appear to have been diverted from more southern to more northern courses, as will be seen by following out on the accompanying map some of the valleys mentioned below.

The valley that runs south-eastward from the Elbow of Clearwater River is one of these old drainage channels, and once carried the waters of the Clearwater southward into the Red Deer. It is wide and sloping, several very well defined terraces extending along the hills on either side.

East branch
of Blind Man
River.

The east branch of Blind Man River also flows in one of these old channels; its source is in the bottom of the valley, in a deep marsh which is drained by two streams flowing in opposite directions and discharging respectively into the Red Deer and into the North Saskatchewan. Just south of the twelfth Base Line, a wide grassy plain, forty feet above the level of the marsh or "muskeg" at the watershed, stretches for several miles along the west side of the stream. The surface of this plain is composed of yellow sandy clay, beneath four feet of which is a deposit twenty feet or more in thickness, of rounded, water-worn quartzite pebbles. These pebbles have evidently been brought down from the quartzite rocks of the mountains by the stream that flowed through the valley, and were spread over the bed of its channel, which at the time expanded here into a shallow lake. Precisely similar deposits have been comparatively recently formed on many of the rivers flowing from the mountains, as for instance, on the Bow River at Calgary, and on the North Saskatchewan at Rocky Mountain House.

Gravel deposit.

Vermilion
River valley.

The valleys of the upper Battle River, of Black Mud, Pipestone and Tail creeks are also ancient river channels. The valley of Vermilion River which, towards the north-west, joins or more probably crosses the North Saskatchewan valley, and, towards the south-east, runs into Grizzly Bear Coulee and the Battle River valley, is an old channel that must have carried a large stream eastward, for it is in many places very wide and deep, with well defined terraces. The valley through which the present stream discharges northward into the North Saskatchewan, is narrow and ill-defined, with steeply scaped banks towards its mouth, and has evidently been much more recently formed than the wide valley through which it flows south-eastward from the "Chain of Lakes."

Age of ancient
river channels.

Whether these valleys date back as far as the bedded clays or not, it is impossible to say at present, on account of the extreme rarity of sections along their sides, but they show clearly an ancient drainage system anterior to the present one, when, perhaps, the rain-fall was

heavier than it is now and considerable accessions were made to the volumes of the streams after they had left the mountains. At present these valleys are being gradually filled up by detrital material washed in from either side, the force of the water, in the existing streams, not being sufficiently great to carry away all the sediment that is being brought down into them.

ECONOMIC MINERALS.

Coals and Lignites.—The enormous deposits of coal and lignite that underlie an area of more than 12,000 square miles in the western part of this district must be considered as first in value and importance among its economic minerals. Analyses of specimens collected from the different seams near their principal outcrops are found on preceding pages, while fuller descriptions and analyses are included in Mr. Hoffmann's report, Part T. Reference might also be made to Dr. Dawson's chapter on coals and lignites in his "Report on the Region in the vicinity of the Bow and Belly rivers,"* where much useful information with regard to western coals and lignites is recorded.

The only true bituminous coal yet found within the district is that outcropping on the edge of the disturbed belt on the eastern side of the first anticlinal seen, as the mountains are approached in ascending the Bow valley. On the north side of the river, one seam two feet ten inches thick was all that was observed, with a strike S. 19° E. and an eastward dip of 30°. The specimen analysed from this outcrop was found to contain a large percentage of ash, while a specimen sent from the opening on the south side of the river, contained less than half as much; but this latter specimen represented, in all probability, the best part rather than the average of the seam.

Taking the thickness of the coal south of the river as seven feet, and assuming that the dip gradually decreases to the eastward, this seam would contain about 9,500,000 tons of coal per square mile.

The extent of this coal-bed to the north and south has not yet been worked out, but there is every reason to suppose that it will be found stretching for many miles on either side of its present known outcrops.

Nearest in character to the bituminous coal, are the lignitic or semi-bituminous coals found on the Red Deer River at the eastern edge of the foot-hills, and in the comparatively undisturbed beds at Rocky Mountain House on the North Saskatchewan, both like the seam on Bow River, in the Paskapoo or upper subdivision of the Laramie. The seam on the Red Deer is almost vertical and so much broken and slick-

* Geol. Survey Report for 1882-84, pp.

ensided that it was very difficult to make out its exact length. It occurs on the continuation of the same anticlinal as the seam at Coal Creek, and, probably, represents the same horizon. It contains a little more hygroscopic water than the coal from this latter seam, but a considerably smaller percentage of ash.

Seam at Rocky
Mountain
House.

The seam at Rocky Mountain House is very irregular, being at the mouth of the Clearwater but eight inches thick, while a mile and a half further north on the North Saskatchewan, it measures from two to three feet. It has a much larger percentage both of water and ash than that from the Red Deer, but is still very compact and capable of being transported for long distances without breaking into fragments. It is hardly possible that this seam can be worked economically at any of the known outcrops, for more than local use, but it is not improbable that other and thicker outcrops may be found in the vicinity from which a large supply could be mined.

Lignite-coals in
Paskapoo series

Of lignite coals the only seam of any considerable thickness at present known in the Paskapoo series, outcrops on the North Saskatchewan twelve miles above the mouth of Yapeoo or Buck Creek in township 49, range 7, west of the fifth principal meridian. The outcrop of this seam is very much obscured by land-slides, but in one place a thickness of fifteen feet of lignite coal was measured and the bottom of the seam was not seen. In another place, five miles distant, the seam was seen to have a thickness of eight feet. Taking, therefore, eleven and a half feet as the mean thickness of this seam throughout the five miles down the river, and assuming that it extends for at least a mile on either side of the river valley, this area would be underlain by 140,000,000 tons of lignite coal. This appears to be the same coal horizon that is represented by a thin seam both on the upper part and near the mouth of Paskapoo or Blind Man River and at the trail crossing on Rosebud Creek.

Lignite-coals in
Edmonton
series.

At the top of the Edmonton series, between four and five hundred feet below the last mentioned seam, there is a very persistent coal horizon that is seen cropping out on the North Saskatchewan with a thickness of twenty-five feet, on the Red Deer with a thickness of ten feet, on Devil's Pine Creek with a thickness of four feet and a half, on Three Hills Creek with a thickness of over two feet, and on Knee Hill Creek with a thickness of four feet. It is impossible, at present, to compute the enormous amount of lignite to be found in this extensive deposit, but the following figures may be given as the quantity that may be relied on with considerable certainty as occurring in the immediate vicinity of some of the above outcrops.

On the North Saskatchewan, the seam was seen to extend in a straight line for three miles retaining its thickness of twenty-five feet; and for

several miles further, large outcrops were seen that could not easily be measured. It was also, in one place, seen to extend a mile back from the river. If we take then a length of three miles of this seam, a width of a mile on each side of the valley, and a thickness of twenty feet, in order to allow for any local constrictions, this small area would be found to contain over 150,000,000 tons. On the Red Deer River the seam contains about 12,500,000 tons per square mile; on Devil's Pine Creek, 5,500,000 tons per square mile, on Knee Hill Creek, 5,000,000 tons per square mile, and in the valley of this latter stream, the seam was traced for from two to three miles down the creek. The line of outcrop of this seam has, therefore, been traced more or less continuously for one hundred and eighty miles, and as will be seen by referring to the preceding pages, the lignite coals at all the outcrops was of good quality.

Thick seam
in North
Saskatchewan
River.

Throughout the Edmonton series, there are various other coal seams of greater or less extent, many of which will be opened as the country becomes more fully developed; but the one that appears to be most persistent is found at a height of about one hundred and sixty feet above the bottom of the series. At the mouth of Rosebud Creek, this seam was found to have a thickness of six feet ten inches, while on Battle River and Meeting Creek, it has a thickness of four feet, representing 5,000,000 tons per square mile. This is essentially the same coal horizon that is again seen at Edmonton, on the North Saskatchewan, though it is hardly likely that the same seam is continuous throughout.

Comparison
with American
coals.

As regards the quality of the lignite coals here met with, analyses and descriptions of specimens from the principal and typical seams are given in the chapter on Descriptive Geology, where the outcrops are referred to, and their general characters are so similar to those already described by Dr. Dawson and Mr. Hoffmann, from the Bow and Belly rivers district, that it is unnecessary to describe them again here.

Many of the coals will compare very favorably with those mined in Eastern America, while the coals and lignites generally are quite equal to those now so largely used in Colorado, Wyoming and other western States.

In the former state,* the total output for 1884 was 1,130,024 short tons, of which the mines at Cañon City yielded 167,995 tons. In 1885 these mines yielded 327,038 tons. "The coal ranks first in the state for all domestic purposes, and is largely used in Denver, while Cañon City and

*The figures and analyses given below are taken from *Mineral Resources of the United States*, 1883-84, Albert Williams, Jr., Washington, Government, 1885, pp. 27-38 and 100-104, and *Mineral Resources of the United States*, 1885, Albert Williams, Jr., Washington, Government, 1886, p. 25.

Pueblo derive their supply almost entirely from these mines." The following is one of the analyses given for this coal:—

	PER CENT.
" Moisture	6.72
Volatile matter	34.76
Fixed carbon	52.70
Ash	5.82
	<hr/> 100.00"

By referring to analyses given in preceding pages of this report, it will be seen that the coal from Coal Creek, near Bow River, as well as that from the edge of the foot-hills on Red Deer River, are not at all inferior to the above, while that from Rocky Mountain House compares very favourably with it.

In 1884, the mines near Erie and Canfield yielded 102,955 tons, and the following analysis is given as showing their general character:—

	PER CENT.
" Water	14.80
Volatile matter	34.50
Fixed carbon	47.30
Ash	3.40
	<hr/> 100.00"

This lignite coal is evidently inferior to that found at Edmonton and on Meeting Creek; it has an amount of water in its constitution equal to or greater than that from any of the seams within this district, though some of these latter contain a much larger percentage of ash than is shown in the above analysis.

In Wyoming, the total output for 1884 was 902,620 short tons, consisting of coals and lignites containing amounts of moisture varying from 6.10 to 15.40 per cent., and showing otherwise general characters very similar to those of the coals and lignites treated of in this report.

Ironstone on
Red Deer River

Iron ore.—In some places along the outcrop of the beds of the Edmonton series, and notably on Red Deer River west of the Hand Hills, a large quantity of clay ironstone is scattered over the face of the clay and sandstone banks, and over the surface of the alluvial flats, which stretch between them and the river. Samples of ironstone similar to that which is here seen, have been analysed by Mr. Hoffmann, and found to contain from 22 to 34.90 per cent. of metallic iron. It occurs, however, in the rocks in very irregular lenticular bands and nodules, so that after what is lying on the surface had been collected, the work of digging it from the banks would give irregular and uncertain results.

Lime and Cement.—Outside the limit of the mountains there is very little limestone in the district, although in the lower part of the Paskapoo series, there are some hard nodular bands which when struck break into irregular angular fragments and which, in some cases, burn down into an excellent lime. Among these bands may be mentioned that on Blind Man River, near the crossing of the Rocky Mountain House trail, and also a band on the banks of the North Saskatchewan River, in township 47, range 9. west of the fifth principal meridian. A good cement could also be made from many of the clayey concretions which are found in immense numbers throughout the shales of the Pierre group. ^{Nodular limestone.}

Clay.—Clay for bricks and pottery can be found in the boulder-clay in considerable quantity as well as throughout the Pierre and Edmonton series. In the latter, a smooth clay is found which bakes to a fine porcelain-like mass, and will, doubtless, be of service in the manufacture of stoneware. ^{Brick-clay, etc.}

Building-Stone.—There are few rocks in this district that can be characterized as good building stones, but in some of the Paskapoo beds, and also in some places in the yellow part of the Belly River series, there are hard grey yellow-weathering sandstones that can be used for buildings of moderate size, where permanency is not regarded as the chief consideration.

Gold, in the form of fine particles, is found in the beds of all the principal streams throughout this area, but especially in the North Saskatchewan, where, after the high water of the early part of the summer has subsided, it is washed out to a considerable extent. The years in which the water is highest, are those in which the miners have made the best wages, the reason being simply, that in those years the largest amount of clay and sand either from the boulder-clay or from the Edmonton series, is washed down from the banks into the stream, and broken up and separated by the water, the clay being carried furthest ^{Gold in the beds of the stream.} west to settle in the quieter parts of the river, while the gold is deposited with the sand and alluvial gravel on bars that cross the bottom of the channel, and which are usually left uncovered in low water.

It is a common error to suppose that, as gold is very heavy, the most of it will settle in the deepest parts of the bed of the stream, and that only a small portion will remain higher up on the bars. This would doubtless be the case if the nuggets were of considerable size, but in the present instance the particles are exceedingly minute, with very irregular surfaces, and easily held suspended in the water for a comparatively long time. It will, therefore, be only in the eddies and quieter ^{Deposited on the bars.}

parts of the stream, the very places where sand and gravel bars are being formed, that these particles of gold will settle to the bottom. In low water, the river is confined almost entirely between banks of alluvial deposits which are not being washed away to any great extent, so that there is very little gold then carried out into the stream, but what is carried out into it, on account of the quieter state of the water, sinks to the deepest parts of the channel; however, the amount moved at this time must be small in comparison with that carried down in high water, almost all of which is deposited on the bars.

APPENDIX I.

ON SOME FOSSILS FROM THE CRETACEOUS AND LARAMIE ROCKS OF THE SASKATCHEWAN AND ITS TRIBUTARIES, COLLECTED BY MR. J. B. TYRRELL IN 1885 AND 1886.*

BY J. F. WHITEAVES.

(A.) CRETACEOUS SPECIES.

LAMELLIBRANCHIATA.

PTERIA LINGUIFORMIS, var. SUBGIBBOSA, Meek.

Avicula subgibbosa, Meek and Hayden. 1860. Proc. Ac. Nat. Sc. Phil., p. 180.

Pteria subgibbosa, Meek. 1864. Smithson. Check-List N. Am. Cret. Foss.

Pteria linguiformis, var. *subgibbosa*, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 33, pl. 28, fig. 12.

Battle River, township 46, range 4, west of the 4th Principal Meridian, 1885.

INOCERAMUS SAGENSIS, var. NEBRASCENSIS, Owen.

Inoceramus Sagensis, Owen. 1852. Geol. Rep. Wisc., Iowa & Minn., p. 582, pl. 7, fig. 3.

Inoceramus Nebrascensis, Owen. 1852. Ib., p. 582, pl. 8, fig. 1.

Inoceramus Sagensis, var. *Nebrascensis*, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 52, pl. 13, figs. 2 a, b.

Inoceramus Sagensis, Whitfield. Pal. Black Hills Dakota, p. 393, pl. 7, fig. 12, and pl. 8, fig. 2.

Mouth of Vermilion River, township 54, range 3, west of the 4th Principal Meridian; North Saskatchewan River, township 54, range 2, west of the 4th Principal Meridian; Nose Creek, section 24, township 44, range 2, west of the 4th Principal Meridian, 1886: one specimen from each of these localities.

* The fossils collected by Mr. Tyrrell in 1884 have already been enumerated or described in "Contributions to Canadian Palæontology, Part I., 1885."

INOCERAMUS VANUXEMI, Meek and Hayden.

- Inoceramus Vanuxemi*, Meek and Hayden. 1860. Proc. Ac. Nat. Sc. Phil., p. 180.
Inoceramus Mortoni, Meek and Hayden. 1860. Ib., p. 428.
Inoceramus proximus, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 53,
 pl. 12, fig. 7; and var. *subcircularis*, Meek, ib., p. 55, pl. 12,
 fig. 2.
Inoceramus Vanuxemi, Whitfield. Pal. Black Hills Dakota, p. 396, pl. 7, figs. 8, 9,
 and pl. 8, figs. 4, 5.

Mouth of Vermilion River, township 54, range 3, west of the 4th Principal Meridian, 1886, five specimens; and North Saskatchewan River, township 54, range 2, west of the same meridian, 1886: two specimens.

GERVILLIA RECTA, var. BOREALIS, Whiteaves.

- Gervillia recta*, var. *borealis*, Whiteaves. 1885. Contr. to Canad. Palæont., vol. I.,
 p. 35, pl. 4, figs. 2, 2 a and 2 b.

Sounding Creek, township 30, range 8, west of the 4th Principal Meridian, 1886: a few characteristic fragments.

TANCREEDIA AMERICANA, Meek and Hayden.

- Hettangia Americana*, Meek and Hayden. 1856. Proc. Ac. Nat. Sc. Phil., vol. VIII., p. 274; and 1860, Ib., vol. XII., p. 185.
Tancredia Americana, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 142,
 pl. 38, figs. 1, a-h.

Same locality and date as the preceding species: two very imperfect and badly preserved specimens.

CYPRINA OVATA, Meek and Hayden.

- Cyprina ovata*, Meek and Hayden. 1857. Proc. Ac. Nat. Sc. Phil., vol. IX., p. 144.
 " " Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 146, pl. 29,
 figs. 7 a, b, c, and pl. 30, fig. 11.

Battle River, township 40, range 13, west of the 4th Principal Meridian, and township 40, range 15, west of the same meridian, 1885: a single and barely recognizable specimen from each of these localities.

CYPRINA SUBTRAPEZIFORMIS. (N. Sp.)

Shell small, inequilateral, transversely subtrapezoidal: valves moderately convex, most prominent on the posterior umbonal slopes, which are subangular: height (in the centre) one-third greater than the maximum breadth: length a little more than one-fourth greater than the height. Anterior side short and evenly rounded: posterior side about three times as long as the anterior, its extremity obliquely truncated above and somewhat bluntly pointed below: superior border descending rather abruptly in an obliquely convex curve in front of the beaks, and nearly straight and parallel with the ventral margin behind them: umbones swollen laterally, but scarcely prominent: beaks small, appressed and slightly depressed, placed about half-way between the centre and the anterior margin: lunule none: posterior area subangularly inflected, but very indistinctly defined: ventral margin nearly straight for the greater part of its length, but rounding up abruptly at the anterior end and forming an obtusely subangular junction with the posterior margin behind.

Surface marked with rather coarse, concentric lines of growth: test somewhat thin. Anterior muscular impression subovate: posterior muscular impression rather larger and more nearly circular: pallial line simple and entire: hinge dentition unknown.

Dimensions of the most perfect specimen collected: maximum length, twenty-three millimetres and a half; greatest height, fifteen mm; approximate thickness through the closed valves, ten mm.

Battle River, township 46, range 4, west of the 4th Principal Meridian, 1885: apparently abundant. About thirty specimens were collected at this locality, but of these, only one is quite perfect, with the whole of the test preserved, while the rest are for the most part little more than mere casts of the interior of the closed valves, with portions of the exfoliated test adherent thereto.

The hinge dentition being unknown, it is uncertain to what genus this shell should be referred. It may prove to be a *Cypricardia* or a *Veniella* rather than a *Cyprina*.

PROTOCARDIA SUBQUADRATA, Evans and Shumard.

Cardium subquadratum, Evans and Shumard. 1857. Trans. Ac. Nat. Sc. St. Louis, vol. I, p. 39.

Protocardia (Leptocardia) subquadrata, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 175, pl. 29, figs. 8 a, b, c, d, e.

Protocardia subquadrata, Whiteaves, as of Shumard. 1885. Contr. to Canad. Palæont., vol. I, p. 41, pl. 5, figs. 4 and 4 a.

Sounding Creek, township 30, range 8, west of the 4th Principal Meridian, 1886: a few well preserved and characteristic specimens.

PROTOCARDIA BOREALIS, Whiteaves.

Protocardia borealis, Whiteaves. 1885. Contr. to Canad. Palæont., vol. I., p. 41, pl. 6, figs. 1, 1 a, 2, 2 a, and 3.

"The Nose," township 27, range 8, west of the 4th Principal Meridian, 1885: two specimens.

LINEARIA FORMOSA? Meek and Hayden.

Tellina formosa, Meek and Hayden. 1860. Proc. Ac. Nat. Sc. Phil., vol. XII., p. 179.

Abra (?) formosa, Meek. 1864. Smithson. Check-List N. Am. Cret. Fossils, p. 14.

Linearia (?) formosa, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 199, pl. 30, fig. 2.

Sounding Creek, township 30, range 8, west of the 4th Principal Meridian, 1886: a perfect right valve of a small Tellinid which corresponds remarkably well with Meek's figure of the above-named species. In the specimen collected by Mr. Tyrrell, however, only the outer surface is exposed to view, the whole of the characters of the interior being buried in the matrix. No traces of any radiating striæ can be discovered on its test, with a lens, although the markings on its outer surface are beautifully preserved, and its test does not appear to have been "very thin."

PHOLADOMYA SUBVENTRICOSA, Meek and Hayden.

Pholadomya subventricosa, Meek and Hayden. 1857. Proc. Ac. Nat. Sc. Phil., vol. IX., p. 142.

Pholadomya subventricosa, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 217, pl. 39, figs. 8, a, b.

North Saskatchewan River, at Fort Pitt, and in township 54, range 2, west of the 4th Principal Meridian, 1886: one nearly perfect specimen with both valves preserved from each of these localities. A portion of a mould of a shell which may have belonged to this species, was collected on the banks of the same river near the mouth of Moose Hill Creek.

Dr. Hector records finding a *Pholadomya* which he refers to *P. occidentalis* of Morton, but which is probably referable to this species, at Fort Pitt, on the North Saskatchewan, and at the elbow of the South Saskatchewan, in 1857 or 1858.

LIOPISTHA UNDATA, Meek and Hayden.

Pholadomya undata, Meek and Hayden. 1856. Proc. Ac. Nat. Sc. Phil., vol. VIII., p. 81.

Pholadomya (Cymella) undata, Meek. 1864. Smithson. Check-List N. Am. Cret. Inv. Foss., pp. 14 and 34.

Liopistha (Cymella) undata, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 236, pl. 39, figs. 1, a, b.

Nose Creek, township 37, range 9, west of the 4th Principal Meridian, 1885: one characteristic specimen.

SOLECURTUS (TAGELUS) OCCIDENTALIS. (N. Sp.)

Shell transversely elongated, a little more than twice as long as high, very nearly equilateral, strongly compressed at the sides, most prominent on the umbonal slopes, and faintly depressed in the middle below. Anterior and posterior ends both rounded at their margins, but rather more broadly so below than above, while the (presumed) posterior extremity is a very little the narrower of the two. Superior border nearly straight for some distance in front of and behind the beaks, which are inconspicuous, central, appressed and depressed; ventral margin nearly straight or very faintly concave in the centre.

Surface apparently marked only with concentric lines of growth. Hinge dentition, muscular impressions and pallial line unknown.

Approximate dimensions of the only specimen collected: maximum height, twenty-three millimetres; greatest length, sixty-seven mm.; thickness through the closed valves, about fourteen mm.

Battle River, township 40, range 13, west of the 4th Principal Meridian, 1885: an imperfect and badly preserved left (?) valve.

MARTESIA TUMIDIFRONS (N. Sp.)

Shell rather large for the genus, very inequilateral, valves subglobose or semiglobose and abruptly swollen in front, produced and rather rapidly attenuated behind; outline, as viewed from above, somewhat pyriform. Greatest height, as measured in the centre, behind the beaks, about equal to the maximum thickness through the closed val-

ves; greatest height, as compared with the maximum length, about as three to five.

Lateral outline transversely subovate; anterior side very short, its outer margin broadly rounded but somewhat truncated inwardly below the middle; posterior side much more elongated, narrowing gradually at its upper margin and much more rapidly from below upwards, its narrow and conspicuously gaping extremity being apparently somewhat obliquely truncated, though the margins of the cast of the united valves of the only specimen collected are both a little broken at this point. Superior border rounding abruptly downward in front, and nearly straight, but descending very gently behind: ventral margin broadly rounded, most prominent a little behind the middle: umbones swollen and prominent: beaks large, incurved and depressed, with a slight forward inclination and placed very near the anterior end: escutcheon broadly lanceolate and tolerably well defined.

On the umbonal region of the left valve only, a small portion of the test is preserved, and the outer surface of this is marked with concentric and rather irregularly disposed, ridge-like folds, which are often separated from each other by somewhat broader and rather deep concentric furrows. In addition to these, in each valve an elevated but narrow linear ridge runs obliquely backward from the posterior side of the beaks to a little behind the centre of the ventral margin.

Posterior muscular impression narrowly subelliptical, placed very high up, almost within the escutcheon, and a little behind the mid-length; anterior muscular impression, pallial line and accessory valves unknown. The pedal opening in front seems to have been large and broadly rhomboidal in outline.

The measurements of the only specimen collected are approximately as follows: maximum length, about fifty-one millimetres; greatest height, as measured in the centre, immediately behind the umbones, and maximum thickness through the closed valves, both thirty-one mm.

North Saskatchewan River, township 54, range 2, west of the 4th Principal Meridian, 1886: one nearly perfect and well preserved cast of the interior of the closed valves, with a small portion of the test adhering to the left valve. An apparently well characterized and very distinct species.

GASTEROPODA.

HYDATINA PARVULA. (N. Sp.)

Shell small, the outer whorl enveloping all the preceding volutions, strongly inflated and very ventricose, so much so, that its maximum breadth is very little less than the entire height or length—subtruncated

posteriorly, broadest above or behind the middle, narrowing rapidly below or in front and distinctly angular at the base or anterior extremity. Spire narrow, depressed and sunk deeply below the highest level or rounded posterior shoulder of the outer whorl.

Outer lip thin and simple: characters of the aperture and surface markings unknown.

Maximum height or length of the only specimen collected, ten millimetres and a-half; greatest breadth of the same, nine mm.

Sounding Creek, township 30, range 8, west of the 4th Principal Meridian, 1886: one perfect cast of the interior of the shell, with a considerable portion of the inner layer of the test preserved, though the aperture is entirely filled up with the matrix.

This interesting little shell may belong to Conrad's genus *Bullopsis*, rather than to *Hydatina*. It seems to differ from *B. cretacea* of that author in being more expanded posteriorly and more angular in front.

LUNATIA CONCINNA, Hall and Meek. (Sp.)

Natica concinna, Hall and Meek. 1854. Mem. Am. Ac. Arts. and Sc., vol. V., p. 384, pl. 3, figs. 2 a, b, c, d.

Natica Moreauensis, Meek and Hayden. 1856. Proc. Ac. Nat. Sc. Phil., vol. VIII, pp. 64 and 282.

Natica (Lunatia) Moreauensis, Meek and Hayden. 1860. Ib., vol. XII., p. 422.

Lunatia concinna, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 314, pl. 32, figs. 11 a, b, c.

Battle River, township 46, range 3, west of the 4th Principal Meridian, 1885: four imperfect and badly preserved specimens. Sounding Creek, township: 30, range 8, west of the same meridian, 1886: one specimen.

CEPHALOPODA.

BACULITES OVATUS, Say.

Baculites ovatus, Say. 1821. Am. Journ. Sc. and Arts, vol. II., p. 41.—Morton. 1829. Journ. Ac. Nat. Sc. Phil., vol. VI., p. 196, pl. 5, figs. 5 and 6; and 1830, Am. Journ. Sc. and Arts, vol. XVIII., p. 249, pl. 1, figs. 6, 7 and 8; also 1834, Synops. Org. Rem. Cret. Group U. S., p. 42, pl. 5, figs. 5 and 6.—Hall and Meek. 1854. Mem. Am. Ac. Arts and Sc., vol. V., (N.S.) p. 399, pl. 5, figs. 1, a, b, and pl. 6, figs. 1-7.—Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 394, pl. 20, figs. 2, a, b, d, and 1, a, b.

Ghost River, township 25, range 6, west the of 5th Principal Meridian, 1885. North Saskatchewan River, near mouth of Moose Hill Creek; also on the same river, in township 52, range 2, and in township 56, range 5, in each case west of the 4th Principal Meridian. Mouth of Vermilion River, in township 54, range 3, west of the same Meridian, 1886.

A few specimens from each of these localities, some of which seem to belong to the typical form of the species, while others are apparently intermediate in their characters between *B. ovatus* and *B. compressus*.

BACULITES GRANDIS, Hall and Meek.

Baculites grandis, Hall and Meek. 1854. Mem. Am. Ac. Arts and Sc., Boston, vol. V., (N. S.) p. 402., pl. 7, figs. 1 and 2, pl. 8, figs. 1 and 2, and pl. 6, fig. 10. Also, Meek, 1876, Rep. U. S. Geol. Surv. Terr., vol. IX., p. 398, fig. 53, and pl. 33, figs. 1, a, b, c.

Sounding Creek, township 30, range 8, west of the 4th Principal Meridian, 1886: two large but fairly characteristic fragments.

BACULITES COMPRESSUS, Say.

Baculites compressus, Say. 1821. Am. Journ. Sc. and Arts, vol. II., p. 41.—Morton. 1834. Synops. Org. Rem. Cret. Group U. S., p. 43, pl. 9, fig. 1; and Journ. Ac. Nat. Sc. Phil., vol. VIII., p. 211.—Hall and Meek. 1854. Mem. Am. Acad. Arts and Sc., Boston, vol. V. (N.S.), p. 400, pl. 5, fig. 2, and pl. 6, figs. 8 and 9.—Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 400, figs. 55 and 56, and pl. 20, figs. 3, a, b, c.

"The Nose," township 37, range 8, west of the 4th Principal Meridian, and Nose Creek, township 37, range 9, west of the same Meridian, 1885.

North Saskatchewan, near mouth of Moose Hill Creek, apparently grading into *B. ovatus*; same river, in township 56, range 5, west of 4th Principal Meridian; mouth of Vermilion River, in township 53, range 3, west of the 4th Principal Meridian: several distorted fragments apparently also passing into *B. ovatus*; North Saskatchewan River, township 54, range 2, west of the 4th Meridian, 1886.

SCAPHITES NODOSUS, Owen.

Scaphites (Ammonites) nodosus, Owen. 1852. Geol. Rep. Surv. Wisc., Iowa and Minn., p. 580, pl. 8, fig. 4.

North Saskatchewan River, near the mouth of Moose Hill Creek,

1886: a fragment of a mould of the exterior of the shell, which shews the characteristic sculpture of the species, but not enough of the general shape to enable one to say to which of the varieties described and figured by Meek (in the ninth volume of the Rep. U. S. Geol. Surv. Terr.) it should be referred.

PLACENTICERAS PLACENTA, Dekay. (Sp.)

Ammonites placenta, Dekay. 1828. Ann. N. York Lyc. Nat. Hist., vol. II, p. 278, pl. 5, fig. 2 (3 by mistake).—Morton. 1829. Journ. Ac. Nat. Sc. Phil., vol. VI, p. 195; and Am. Journ. Sc. and Arts, vol. XVIII, pl. 2, figs. 1, 2 and 3; also 1834, Synops. Org. Rem. Cret. Form. U. S., p. 36, pl. 2, figs. 1 and 2.

Placenticeras placenta, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX, p. 465, pl. 24, figs. 2, a, b.

Battle River, township 40, range 13, west of the 4th Principal Meridian, 1885: a small fragment.

Sounding Creek, township 30, range 8, west of the same meridian, 1886; a single but nearly perfect specimen which measures nearly nine inches in its greatest diameter.

CRUSTACEA.

PALÆASTACUS (?) ORNATUS. (N. Sp.)

The foregoing is suggested as a provisional name for a rather remarkable specimen of a long tailed decapod, which evidently belongs to the family *Astacomorpha* of Zittel. Of the Cretaceous representatives of this family, it seems to come nearest to such genera as *Palæastacus* and *Hoploparia*, though it differs from each in some important particulars. In many respects it appears to the writer to be still more nearly related to the recent and fresh-water genera *Astacus* and *Cambarus*, but there is good reason for supposing that it will eventually prove to be the representative of a new generic type, which at present there is not sufficient material to define satisfactorily.

Nearly the whole of the under surface of the cephalothorax of the specimen is buried in the matrix, the front margin of the carapace is very imperfect, the tail fin as well as the under part of the five abdominal segments are broken off, and only small portions of the pinching claws and of the other ambulatory legs are preserved or exposed.

The carapace is moderately convex or slightly depressed, and not quite twice as long as broad. It is divided into two nearly equal parts by a single, well marked and deeply impressed neck furrow, which is

arched forward in a shallowly concave curve. Behind this furrow the lateral margins of the carapace are slightly expanded, the test in the branchial region is moderately inflated, and the posterior margin is shallowly concave in the middle. A short distance in advance of the neck furrow, on the outer and lower portion of the carapace, on each side, there is a very short and transverse groove or narrow constriction, which may possibly be confluent with the neck furrow on the strongly inflected lateral margins of this part of the carapace. The exact outline of the anterior margin of the carapace cannot be ascertained, and the tip of the rostrum is broken off. The basal portion which remains is about seven or eight millimetres long. At the base it measures five mm. in breadth, and at the broken anterior extremity its breadth is two mm. Its outer margins are defined by two linear and acute, tuberculated and raised longitudinal ridges, between which the surface is smooth and concavely excavated.

The whole of the outer surface of the carapace is ornamented by rather distant, isolated tubercles. In its posterior moiety these tubercles are somewhat irregularly disposed, though there is a low, very narrow, and rather inconspicuous keel on the median line, on either side of which the cardiac region is comparatively smooth. On the anterior portion of the carapace the tubercles are grouped somewhat obscurely in two or three longitudinal rows on both sides of the narrow median keel, which is continued with greater or less distinctness up to the commencement of the rostrum.

The anterior pinching claws appear to have been unusually short and robust, while their surface is distinctly tuberculated. The portions of the posterior ambulatory legs that happen to be preserved, on the other hand, are very slender, and their surface is minutely granulated. The abdominal segments are badly preserved, but their outer surface seems to have been smooth, though a narrow median keel can be traced throughout the greater part of their dorsal surface.

Sounding Creek, township 30, range 8, west of the 4th Principal Meridian, 1886.

At the same locality and date five detached pinching claws of an apparently second species of decapod were collected in as many concretionary nodules. These claws resemble those of *P. ornatus* in the comparative shortness and robustness of their terminal segments, but the outer surface of the latter is finely granulated rather than coarsely tuberculated.

FISHES.

A well preserved tooth of a Selachian was collected on the Battle River, in township 46, range 3, west of the 4th Principal Meridian, in 1885; and a pectoral fin, apparently of a large selachian, at Sounding Creek, township 30, range 8, west of the 4th Principal Meridian, in 1886.

(B.) LARAMIE SPECIES.

LAMELLIBRANCHIATA.

UNIO DANÆ, Meek and Hayden.

Unio Danæ, Meek and Hayden. 1857. Proc. Ac. Nat. Sc. Phil., vol. IX, p. 145.

" " Meek. 1876. U. S. Geol. Surv. Terr., vol. IX, p. 517, pl. 41, figs. 13, a, b, c.

Bow River, opposite mouth of Fish Creek, 1886: a few very badly preserved specimens.

SPHÆRIUM FORMOSUM? Meek and Hayden, Var.

Sphærium formosum? Meek and Hayden, var. Whiteaves. 1885. Contr. to Canad. Palæont., vol. I, p. 61, pl. 9, fig. 3.

Blind Man River, township 40, range 1, west of the 5th Principal Meridian: two or three detached single valves.

As pointed out in the memoir cited, "it is doubtful whether this *Sphærium* should be regarded as merely a local variety of the *S. formosum*, or as a distinct species."

GASTEROPODA.

LIMNÆA TENUICOSTATA, Meek and Hayden.

Limnæa tenuicostata, Meek and Hayden. 1856. Proc. Ac. Nat. Sc. Phil., p. 119.

Limnæa (Acella) tenuicostata, Meek and Hayden. 1860. Ib., p. 431.

Limnæa (Pleurolimnæa) tenuicostata, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 534, pl. 44, figs. 13, a, b, c.

Blind Man River, township 40, range 1, west of the 5th Principal Meridian, 1885; a few specimens of what appears to be an unusually

fine-ribbed variety of this species, in which there are from eighteen to twenty ribs on the outer whorl, instead of from eight to twelve as in the typical form.

PHYSA COPEI, White, var. CANADENSIS.

Physa Copei, var. *Canadensis*, Whiteaves. 1885. Contr. to Canad. Palæont., vol. I., p. 14, pl. 2, figs. 5, 5 a and 5 b.

Blind Man River, township 40, range 1, west of the 5th Principal Meridian, 1885; one crushed specimen: also Bow River, section 32, township 22, range 29, west of the 4th Principal Meridian, 1885: a fragment which probably belongs to this species.

BULIMULUS (THAUMASTUS) LIMNÆIFORMIS, Meek and Hayden.

Bulimus limnæiformis, Meek and Hayden. 1856. Proc. Ac. Nat. Sc. Phil., vol. VIII., p. 118.

Thaumastus limnæiformis, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 553, pl. 44, figs. 8, a, b, c, d.

" " Whiteaves. 1885. Contr. to Canad. Palæont., vol. I., pp. 20, 27 and 72, pl. 3, fig. 3.

Bow River, section 32, township 22, range 29, west of the 4th Principal Meridian, 1885: abundant.

On the Red Deer River (in township 39, range 27, west of the 4th Principal Meridian), a fragment of a slender, reversed land shell, which appears to be congeneric with the *Columna teres* and *C. vermicula* of Meek and Hayden, was collected in 1885. The specimen consists of a natural mould of the exterior of one side of the shell, with portions of the test adherent thereto. In general outline, as well as in the amount of obliquity in its suture, it resembles *C. vermicula* more than *C. teres*, but differs from both in having only eight volutions at most, instead of twelve or thirteen.

GONIOBASIS TENUICARINATA, Meek and Hayden.

Melania tenuicarinata, Meek and Hayden. 1857. Proc. Ac. Nat. Sc. Phil., vol. IX., p. 137.

Goniobasis tenuicarinata, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 566, pl. 43, figs. 14, a, b, c.

" " Whiteaves, 1885. Contr. to Canad. Palæont., vol. I., pp. 22 and 27, pl. 3, figs. 5 and 5 a.

Red Deer River, township 39, range 27, west of the 4th Principal Meridian, 1885; and Blind Man River, Crossing of Rocky Mountain House trail, in Township 40, Range 1, west of the 5th Principal Meridian: a single specimen from each of these localities.

VIVIPARUS LEAI, Meek and Hayden.

Paludina Leai, Meek and Hayden. 1856. Proc. Ac. Nat. Sc. Phil., vol. VIII., p. 121.

Vivipara Leai, Meek & Hayden. 1860. Ib., vol. XII., p. 185.

Viviparus Leai, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 577, pl. 44, figs. 6, a, b, c, d.

Viviparus Leai, Meek and Hayden. White. 1883. Rev. Non-Marine Foss. Moll. N. Am., p. 61, pl. 27, figs. 10-14.

Blind Man River, Crossing of Rocky Mountain House trail, in township 40, range 1, west of the 5th Principal Meridian, 1886: a few well preserved and typical specimens.

VIVIPARUS TROCHIFORMIS, Meek and Hayden, Var.

Paludina trochiformis, Meek and Hayden. 1856. Proc. Ac. Nat. Sc., Phil., vol. VIII., p. 122.

Vivipara trochiformis, Meek and Hayden. 1860. Ib., vol. XII., p. 185.

Viviparus trochiformis, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 580, pl. 44, figs. 2, a-e; also, White, 1883, Rev. Non-Mar. Foss. Moll. N. Am., p. 61, pl. 24, figs. 10-16.

Bow River, section 32, township 22, range 29, west of the 4th Principal Meridian, 1885: twelve specimens.

These represent a variety in which the two spiral ridges which are usually characteristic of the species are entirely obsolete, and the minute spiral revolving lines are almost completely undeveloped.

CAMPELOMA MULTILINEATA, Meek and Hayden.

Paludina multilineata, Meek and Hayden. 1856. Proc. Ac. Nat. Sc., Phil., vol. VIII., p. 120.

Vivipara multilineata, Meek and Hayden. 1860. Ib., vol. XII., p. 85.

Campeloma multilineata, Meek. 1876. Rep. U. S. Geol. Surv. Terr., vol. IX., p. 586, pl. 44, figs. 1 a, b.

" " White (as of M. & H.) 1860. U. S. Geol. Surv., Contr. to Pal., Nos. 2-8, p. 101, pl. 28, figs. 4 a, b.

" " White. (as of M. & H.) 1883. Rev. Non-Marine Foss. Moll. N. Am., p. 63, pl. 27, figs. 1-7.

Same locality and date as the preceding species : three specimens. This shell, in the writer's judgment, is a typical *Lioplax*.

CAMPELOMA PRODUCTA, White.

Campelema (Lioplax) producta, White. 1883. Rev. Non-Marine Foss. Moll. N. Am., p. 63, pl. 26, figs. 21-27.

Campelema producta (White.) Whiteaves. 1885. Contr. to Canad. Palæont., vol. I., pp. 24, 28 and 77.

Same locality and date as the two preceding species ; also Blind Man River, crossing of Rocky Mountain House Trail, in township 40, range 1, west of the 5th Principal Meridian, 1886 : abundant at each of these localities.

Notwithstanding the difference in the generic and specific name, this species seems to be very nearly related to the *Goniobasis Nebrascensis* and *G. tenuicarinata* of Meek and Hayden.

VALVATA BICINCTA, Whiteaves.

Valvata bicincta, Whiteaves. 1885. Contr. to Canad. Palæont., vol. I., p. 25. pl. 3, figs. 8, 8 a, and 8 b.

Blind Man River, township 40, range 1, west of the 5th Principal Meridian, 1885 : abundant.

VALVATA FILOSA, Whiteaves.

Valvata filosa, Whiteaves. 1885. Contr. to Canad. Palæont., vol. I., p. 25, pl. 3, figs. 7 and 7 a.

Same locality and date as for the preceding species.

[This Appendix, with illustrations of the new species, will be re-printed in Part II. of the Contributions to Canadian Palæontology, now in course of publication.—J. F. W.]

APPENDIX II.

LISTS OF LEPIDOPTERA COLLECTED BY MR. J. B. TYRRELL IN 1884 AND 1885, AND MR. D. B. DOWLING IN 1886.

BY

MR. JAMES FLETCHER.

DIURNAL, 1884, 1885.

- | | | | |
|-----|--|---|-----------------------------|
| 1. | <i>Colias Eurytheme</i> , Bd., summer form
<i>Eurytheme</i> , Edw..... | } | |
| 2. | " " tetramorphic form
<i>Eriphyle</i> , Edw..... | } | |
| 3. | " <i>Occidentalis</i> , Scud..... | } | Red Deer River, near cross- |
| 4. | " <i>Christina</i> , Edw..... | } | ing of old trail to Rocky |
| 5. | <i>Argynnis Cybele</i> , Fab..... | } | Mountain House, June |
| 6. | " <i>Lais</i> , Edw..... | } | 21-July 13, 1885. |
| 7. | " <i>Clio</i> , Edw..... | } | |
| 8. | " <i>Triclaris</i> , Hub..... | } | |
| 9. | <i>Phyciodes Carlotta</i> , Reak..... | } | Red Deer River, near the |
| | | } | mouth of Rosebud Creek, |
| | | } | June 13 and 16, 1884. |
| 10. | " <i>Tharos</i> , Dru., dimorphic form
<i>Morpheus</i> , Fab..... | } | Battle River, Tod's Cross- |
| 11. | <i>Vanessa Milbertii</i> , Godt..... | } | ing, July 19, 1885. |
| 12. | <i>Limenitis Arthemis</i> , Dru., dimorphic form
<i>Lamina</i> , Fab..... | } | July 3, 1885. |
| 13. | <i>Cænonympha Ochracea</i> , Edw..... | } | Red Deer River,* June 21- |
| 14. | <i>Erebia Epipsodeu</i> , Butler..... | } | July 13, 1885. |
| 15. | <i>Satyrus Charon</i> , Edw..... | } | Coal Creek, July 27, 1884. |
| 16. | <i>Lycæna Sæpiolus</i> , Bd..... | } | Red Deer River,* June 21- |
| 17. | " <i>Lygdamas</i> , Doub..... | } | July 13, 1885. |

DIURNAL, 1886.

- | | | | |
|----|--|--|-----------------------------|
| 1. | <i>Pieris Napi</i> , Esper., summer form <i>Oleracea-</i>
<i>Æstiva</i> , Harr..... | | Near Vermilion R., July 27. |
|----|--|--|-----------------------------|

* Near crossing of old trail to Rocky Mountain House.

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|-----|---|------------------------------|
| 2. | <i>Colias Eurytheme</i> , Bd., summer form <i>Eurytheme</i> , Edw..... | Near Edmonton, Sept. 9. |
| 3. | “ “ tetramorphic form <i>Eriphyle</i> , Edw..... | Near Vermilion R., July 27. |
| | “ “ “ | The Three Hills, Sept. 20. |
| 4. | “ <i>Occidentalis</i> , Scud..... | Saddle Lake, July 29. |
| 5. | “ <i>Interior</i> , Scud..... | Miry Creek,* July 19. |
| 6. | <i>Danaïs Archippus</i> , Fab..... | Bear Hill Reserve, Sept. 12. |
| 7. | <i>Argynnis Cybele</i> , Fab..... | Miry Creek, July 19. |
| 8. | “ <i>Lais</i> , Edw..... | “ “ “ |
| 9. | “ <i>Boisduvallii</i> , Somm..... | “ “ “ |
| 10. | “ <i>Bellona</i> , Fab..... | “ “ “ |
| 11. | <i>Phyciodes Tharos</i> , Dru., summer form <i>Morpheus</i> , Fab..... | Saddle Lake, July 20. |
| 12. | <i>Vanessa Antiopa</i> , L..... | Miry Creek, July 19. |
| 13. | <i>Pyrameis Cardui</i> , L..... | Saddle Lake, July 20. |
| | “ “ | Vermilion River, Aug. 10. |
| 14. | <i>Limenitis Arthemis</i> , Dru., dimorphic form <i>Lamina</i> , Fab..... | Saskatchewan, July 19. |
| 15. | <i>Satyrus Alope</i> , Fab., dimorphic form <i>Nephele</i> , Kirby | Vermilion River, July 28. |
| 16. | “ “ var. <i>Olympus</i> , Edw..... | “ “ “ |
| 17. | “ “ var. <i>Boopis</i> , Behr..... | “ “ “ |
| 18. | <i>Chrysophanus Thoe</i> , Bd. Lec..... | Miry Creek, July 19. |
| | “ “ | Vermilion River, July 28. |
| 19. | “ <i>Florus</i> , Edw..... | Miry Creek, July 19. |

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| 1. | <i>Sphinx Albescens</i> , Tepper..... | Bull Pound Creek, May 16. |
| 2. | <i>Syneda Athabasca</i> , Neum..... | Buffalo Coulee, June 22. |
| 3. | <i>Phasiane Aberrata</i> , H. Edw..... | Battle River, near Buffalo Creek, June 25. |
| 4. | <i>Eufitchia Ribesata</i> , Fitch..... | Battle River, near Buffalo Creek, June 25. |
| 5. | <i>Agrotis Clandestina</i> , Harr..... | Iron Creek, June 29. |
| 6. | <i>Arctia Virgo</i> , L..... | Beaver Lake, July 8. |
| 7. | <i>Plusia Californica</i> , Spey..... | Edmonton, July 15. |
| 8. | <i>Botis Fodinalis</i> , Pack..... | Edmonton, July 15. |
| 9. | <i>Metrocampa Perlaria</i> , Guen..... | Edmonton, July 15. |
| 10. | <i>Acidalia nivosata</i> , Guen..... | Battle River, near Buffalo Creek, June 25. |

* Ten miles east of Victoria on the trail north of the North Saskatchewan river.

APPENDIX III.

LIST OF ELEVATIONS.*

The following are the elevations of the stations on the Canadian Pacific Railway, within the limits of the accompanying map:—

	FEET ABOVE SEA LEVEL.
Cochrane.....	3,712
Radnor.....	3,825
Morley.....	4,032

The following are points on the old location line of the Canadian Pacific Railway, the heights of which have been instrumentally determined, and are given in the Canadian Pacific Railway Report, 1877. They were leveled up from Lake Superior, which was taken at 596 feet above mean tide level, a height which is six feet too low. Six feet must, therefore, be added to all the heights given in this table. The positions of these points are laid down on the map with as much accuracy as the information at our disposal would permit.

	FEET ABOVE SEA LEVEL.
F.....	2,125
G.....	2,101
H.....	2,165
Grizzly Bear.....	2,145
I.....	2,210
K.....	2,240
L.....	2,325
M.....	2,325
N.....	2,243
O.....	2,287
P.....	2,363
Q.....	2,473

* During the summer of 1887, Mr. Warren Upham while tracing out and levelling the beaches of the glacial lake Agassiz in Manitoba, found that the O point on the Canadian Pacific Railway just west of Winnipeg had been taken at 737 feet, instead of 759 feet, which is its true elevation above mean tide. All the elevations, therefore, from Winnipeg to the Rocky Mountains which are based on this O point are 22 feet too low. This will leave the cistern of the barometer at Calgary 3,411 feet instead of 3,389 feet, as stated above; and 22 feet must be added to all the heights given in this report, except those of the old location of the Canadian Pacific Railway. For early information on this subject, I am indebted to the kindness of Mr. Warren Upham himself.

R.....	2,500
Highest point on this part of the line.....	2,555
S.....	2,500
Edmonton.....	2,413
Grandin.....	2,380
Crossing of North Saskatchewan, 104 feet above the river.....	2,200
Siksika.....	2,320
Laplaire.....	2,422
Palliser.....	2,413
Belcour.....	2,407

The following are some of the elevations that were determined with a mercurial barometer compared with the standard barometers used at Calgary, Medicine Hat and Edmonton. The readings were usually taken at the same time as the readings of the standards; but when this was impossible, corrections were in every case made for the difference in time.

Compared with Calgary (3389 ft.) and Medicine Hat (2142 ft.):—

	FEET ABOVE SEA LEVEL.
Lorne Crossing, Red Deer River.....	2,167
Berry Creek, at Lorne trail.....	2,412
Sounding Creek, Lorne trail.....	2,449
Elbow of Sounding Creek (7 readings).....	2,174
Sounding Lake.....	2,140
Ribstone Creek, near the western limit of range 8....	2,330
Ribstone Creek, in southwest corner of township 40, Range 6.....	2,192
Battle River, crossing of Fort Pitt trail.....	1,894
Lake in Blackfoot Hills.....	2,249
Buffalo Creek, one mile from Battle River.....	1,942
Iron Creek, ten miles above its mouth.....	2,051

Compared with Calgary:—

Bigstone Creek, Calgary-Edmonton trail.....	2,460
Battle River, Leavings ".....	2,457
Wolf Creek ".....	2,613
Lone Pine ".....	3,290
Rosebud Creek, ".....	3,232
Small lake in tp. 28 ".....	3,577
Battle Lake.....	2,770
Mouth of Pigeon Lake Creek.....	2,719
Egg Lake (near Victoria).....	1,997
Blind Man River, crossing of Rocky Mountain House trail (38 readings).....	2,827
Medicine River ".....	2,995
Western lake of "Chain of Lakes".....	1,921
Rocky Mountain House.....	3,153
Bear Lake.....	2,624

Compared with Edmonton, the height of which is taken as 2,210 feet :

Beaver Lake.....	2,178
Mouth of Smoky Creek	1,871
Mouth of Saddle Lake Creek.....	1,823
Saskatchewan River at Fort Pitt.....	1,722
Mouth of Brazeau River.....	2,637
Big Coal Seam on Saskatchewan River.....	2,307
Pigeon Lake.....	2,824
Weed Creek, crossing of Pigeon Lake trail	2,566

The following elevations were taken with aneroids during the summer of 1886, compared with the standards at the places mentioned in brackets :—

Birch Lake (Edmonton).....	2,140
Cooking Lake “	2,400
Hastings Lake “	2,380
Buck Lake (Crossing of Blind Man River).....	2,970
Gull Lake “ “ “	2,905
(Black Butte.....)	2,190)
Red Deer River, crossing of Calgary-Edmonton trail, (Calgary and Edmonton).....	2,727

The following are some of the principal elevations obtained with aneroids during the summer of 1885, compared with readings of the standard at Calgary :—

Little Red Deer River at outer edge of foot-hills.....	3,979
Little Red Deer River, at crossing of Rocky Mountain House trail.....	3,192
Fallen Timber Creek, edge of foot-hills.....	4,448
Fallen Timber Creek, at its mouth.....	3,753
Red Deer River, Stoney pack-trail.....	4,328
“ “ edge of foot-hills	3,955
“ “ Rocky Mountain House trail.....	3,172
Battle River Settlement, top of bank.....	2,408
Egg Lake (in Hand Hills).....	2,970
Mouth of Tail Creek.....	2,390
Dried Meat Lake.....	2,230
Elbow of Battle River	2,125
Little Fish Lake.....	2,890
Top of Hand Hills.....	3,555

APPENDIX IV.

CREE AND STONEY INDIAN NAMES FOR PLACES WITHIN THE AREA OF THE ACCOMPANYING MAP.

The greater number of these names were obtained from William Kitchipwat, a Stoney Indian from the Morley reserve, who worked for me during part of the summer of 1885, and for the rest I am indebted to Mr. McKay, an educated Cree half-breed, who was in charge of the Hudson's Bay Company's post at Fort Pitt, and to James Prudens, jr., and Simon Fraser, two other Cree half-breeds.

In the majority of cases, the English name is merely a translation of the Cree, but where this is not the case, the meaning of the Indian word is printed under it in brackets. The Stoney name is also generally a translation of that used by the Crees, but when it differs, its meaning is printed under it in the same way. Where the syllables were sharply defined in pronunciation, they have been separated by a hyphen, but where they were run rapidly together, the hyphen has been omitted.

The following list of vowels and diphthongs will show the sound that each is intended to represent. The list is essentially the same as that used by Drs. Tolmie and Dawson in their "Comparative Vocabulary of the Indian Tribes of British Columbia":—

<i>a</i>	as in English	.....	<i>fat.</i>
<i>ā</i>	" "	.....	<i>father.</i>
<i>e</i>	" "	.....	<i>met.</i>
<i>ē</i>	" "	.....	<i>they.</i>
<i>i</i>	" "	.....	<i>pin.</i>
<i>ī</i>	" "	.....	<i>marine.</i>
<i>o</i>	" "	.....	<i>go.</i>
<i>u</i>	" "	.....	<i>nut.</i>
<i>ai</i>	" "	.....	<i>aisle.</i>
<i>oi</i>	" "	.....	<i>join.</i>
<i>ōo</i>	" "	.....	<i>pool.</i>
<i>ow</i>	" "	.....	<i>now.</i>

* Special Report of Geol. Survey, 1884.

INDIAN NAMES OF PLACES.

ENGLISH.	CREE (Ni-hī-a-wē'.)	STONE (As-sin-pwā-tis)
<i>Buffalo Lake</i>	Moos-toos Sa-kha'-higan.....	Ta-toong-gāma
<i>Buck</i> ".....	Ya'-pē oo ".....	Tam-no-āma
<i>Gull</i> ".....	Kī-as'-koos ".....	Pi-chat-to āma
<i>Snake</i> ".....	Kin-a-pik' ".....	Mno-hemna
<i>Swan</i> ".....	Wā'-pi-sioo ".....	Ko-gāma
<i>Pigeon</i> ".....	Hmī-hmoo ".....	Ka-ka-gāma
<i>James River Lakes</i>	Ji-mis Si-pi (Woodpecker Lake.).....	Ji-mis-wap tim'ni
<i>Devil's Lake</i> (in Rocky Mountains.).....	Ki-no-ka-mak' (Long Lake.).....	Mnith-to
<i>Dead Wood Lake</i> (between Clearwater R. and Prairie Creek).....	.....	Che-shem'na
<i>Wood Lake</i>.....	.....	Cha-gam'na
<i>Hollow</i> ".....	.....	Mi-hi-dwā
<i>Muskeg</i> ".....	.....	Tāsāk-tem'na
<i>Egg</i> ".....	Ma-na-wān Sa-kha'-higan.....	
<i>Sounding</i> ".....	Ni-pik-ap-hit-i-kwek (Sounding water.).....	
<i>Saddle</i> ".....	O-nis-chik-hskop'-uwin Sa-kha'-higan.....	
<i>Frog</i> ".....	Ah-yik Sa-kha'-higan.....	
<i>Onion</i> ".....	Wis-chēk-oos-o-sioo ".....	
<i>Stony</i> ".....	Sin-is-kow' ".....	
<i>Fishing</i> ".....	Pu-ka-che-wān' (Little fishing place.).....	
<i>Crooked</i> ".....	Wā-wā-ka'-tin-ow ".....	
<i>Lake St. Ann</i>	Ma-ni-to (Spirit Lake.).....	
<i>Lac la Nonne</i>	Mi-ka-sioo (Eagle Lake.).....	
<i>Big Lake</i>	Mis-ta he ".....	
<i>Dried Meat Lake</i>	Kā-ke-wuk' ".....	
<i>Sullivan</i> ".....	Ka-ki-no-ka-mak' (Long Lake.).....	
<i>Dry Grass</i> ".....	Pa-kwas-kow ".....	
<i>Hay</i> ".....	A-pī'-chī-koo-chī-wās' (Little swamp.).....	
<i>Bear</i> ".....	Mus-kwa-chi Sa-kha'-higan (Bear Hills Lake.).....	
<i>Bittern</i> ".....	Mo-kā'-kā-sioo ".....	
<i>Beaver</i> ".....	A-misk-wā-chi (Beaver Hills Lake.).....	
<i>Rolling Hills Lake</i> (east of Hay L. trail).....	Pi-ti-koo-ka-mow' ".....	
<i>White Wood Lake</i>	Wa-pi-ta-kow' ".....	
A N. and S. chain of lakes in the hills, 15 miles S. W. of Beaver Lake.		
<i>Flat Lake</i>	Ka-ta-ta-kwa-cha-o-ka-mak.....	

INDIAN NAMES OF PLACES—Continued.

ENGLISH.	CREE (Ni-hī-a-wē'.)	STONEY (As-sin-pwā-tis)
<i>Two lakes east of Flat Lake</i>	Si-wi-tā'gan Sa-kha'-hī-gana. (Salt Lakes.)	
<i>Dusty Lake</i>	Ko-pwa-o-wa-gas-takh	
<i>Island</i> "	Ka-min-ta'-gu-sikh	
<i>Birch</i> "	Was'-kwa-i Sa-kha'-hīgan	
<i>Cooking</i> "	O-pi-mi-now'-wa-sioo "	
<i>Hastings</i> "	A-ka-ka'-kwa-tikh	
	(The lake that does not freeze.)	
<i>Red Deer River</i>	Was'-ka-sioo Si-pī	Pa-chī-dī-wāp-ta
<i>Little Red Deer River</i>	Was-ké'-sis Si-pī'-sis	" wāp-tan
<i>Ghost River</i>	Chi'-pē-i Si-pī	Win-chin-a-i-wāp-ta
<i>Fallen Timber Creek</i>	Kow-ikh-ti-kow' Si-pī'-sis	O-ta-ha-wāp-ta
<i>Bearberry Creek</i>	A-chuk-i-si'-pī "	A-be-wāp-tan
<i>James River</i>	Ji-mis Si-pī	Ji-mis-tumb-wāp-ta
<i>Dog Pound Creek</i>	Ko-ma-tas'-ta-moin Si-pī'-sis	So-mun-ib- "
	(Stolen Horse (or Dog) Creek.)	
<i>Clearwater River</i>	Wā-sé'-ga-mow Si-pī	Mnith-ow'- "
<i>Blind Man</i> "	Pas-ka-poo "	Is-tap-ta- " or Cham-bath-na- dab-wāp-ta (Dead standing-timber River.)
<i>Bow</i> "	Ma-na-chā'-ban "	Mi-nith-ni (Cold River.)
<i>Raven</i> "	Ka-ka-koo' "	Kai'-him-bu-wāp-ta
<i>Medicine</i> "	{ Mās-kī'-kīoo "	To-go-wāp-ta (Mussel River.)
	{ Ni-pa-gwā'-si-mow "	
	(Sun dance River.)	
<i>Horse Pound Creek</i>	Ka-ni-wās'-ta-moin Si-pī'-sis	Soon-kowīng-wuab- wāp-ta
	(Horse-guard Creek.)	
<i>Battle River</i>	No-tin'-to Si-pī	Ke'-chi-sab-wāp-ta
<i>Open Creek</i> (The creek that does not freeze)	As-kow-i Si-pī'-sis	So'-men-ib- "
<i>Muskrat Cr.</i> (flows into Prairie Cr. from N.)	Wa-cha'sk "	Hthump-to-dab-wāp-ta
<i>Pigeon Lake Creek</i>	Hmī-hmoo Sa-kha'-hīgan Si-pī'-sis	Ke-gemni-wāp-ta
	(Woodpecker lake Creek.)	
<i>Elbow River</i>	O-toos-kwa-na' Si-pī'-sis	Nm-no-tho-āp-ta
<i>Wolf Creek</i>	Mu-hī-khan' "	Sik-to-do- "
<i>Smoky River</i>	Kas-ka'-pi-tē Si-pī	Swo-da- "
<i>Brazeau</i> "		Tum-wāp-ta
<i>Prairie Creek</i>	Mas-kioo-tē'-oo "	Tin-dow-wāp-ta
<i>Saskatchewan</i>	Kis-is-ska-tche-wan	Wāp-tam-notha
	(Rapid river.)	
<i>Grease Creek</i>	To'-muna Si-pī'-sis	Sna-tin-da-wāp-ta
<i>Tail</i> "	O-soo-i' "	Sin-doo- "
<i>Rosebud</i> "	Mis-sas-ka-too'-mina Si-pī'-sis	Mi-tha'ga-wāp-tan
	(Service Berry Creek.)	
<i>Nose</i> "	Os-kewun' "	Tap-o-oi-wāp-ta

INDIAN NAMES OF PLACES—Continued.

ENGLISH.	CREE (Ni-hi-a-wē'.)	STONE (As-sin-pwā-tis)
<i>Jumping Pound Creek</i>		To-ko-jap-tab-wāp-ta
<i>Egg</i> "	Man-a-wān Si pi'-sis.....	
<i>White Earth</i> "	Wā-pi-tan-isk' "	
<i>Pipestone</i> "	Man-is-pwā'-ga-nan "	
	(The creek where pipes are got.)	
<i>Frog</i> "	Ah-yik-i "	
<i>Moose</i> "	Moos-wa-chī'-wī "	
	(Moose Hill Creek.)	
<i>Dog</i> "	A-tim O-soo-i-kun' "	
	(Dog Rump Creek.)	
<i>Vermilion River</i>	Wē-i-mun' Si-pi'	
<i>Conjuring Creek</i>	Pāw-ga-mow Si-pi'-sis.....	
	(Vomiting Creek.)	
	or Mi-tē-oo "	
<i>Strawberry Creek that does not freeze</i> (in Beaver Hills.)...	A-te-min "	
<i>Halfway Creek</i>	A-ka-ka'-kwa-tikh "	
<i>Cache</i> "	A-pi-tow "	
<i>Weed</i> "	As-tākh'-si-kun "	
<i>Hay</i> "	At-che-kas-puk "	
<i>Hay</i> "	Mas-kioo-si-kan "	
<i>Crooked</i> "	Wā-wā-ka'-tin-ow "	
<i>Grizzly Bear Creek</i>	Mist ā-yā "	
<i>Ribstone</i> "	As-sin-i-kos-pi-kē-gan-it	
<i>Iron</i> "	Pi-wa-pisk-oo Si-pi'-sis	
<i>Meeting</i> "	Nukh-kwa-ta-to "	
<i>Stony</i> "	Ka-as-sin-is-kak "	
<i>Sturgeon River</i>	Mi-koo-oo-pow Si-pi'	
	(Red Willow Creek.)	
<i>Rivière qui Barre</i>	Ma-ta-hi-to Si-pi'-sis	
	(Present Creek.)	
<i>Hastings Creek</i>	Kak-si'-chī-wukh'	
	(Swift Current.)	
<i>Deep</i> "	Ka-ta-mikh Si-pi'-sis	
<i>Beaver</i> "	A-misk-wā-chī-oo "	
<i>Black Mud</i> "	Kas-ki-tē'-oo as-is-ki. "	
<i>Rocky Mountains</i>	As-sin-wāti	Ni-a'-ha
<i>Devil's Head Mtn</i>	Wē-ti-kwos'-ti-kwan	Si-ham'-pa
<i>Eagle Hill</i>	Ki-hi-a-wātis	Mha-moos-ni-bin
<i>Hat Mountain</i> (near source of Clear-water River).....	As'-tu-tin As-sin-wāti	Ni-a-he-tis na-ki-ta-wan
<i>Hand Hills</i>	Mi-chī-chī Is-pa-tin-an	O-chun-um-bin
<i>Three</i> "	Nis-to "	Pa-ha-am-ni
<i>Knee</i> "	Mi-chig-wun "	Che-swun-de-ba-ha
<i>Antler Hill</i>	Wās-ka-suk is-kun ka-so-pit.....	Pa-chi-di ha-ba jo-bi
	(The pile of Elk horns.)	
<i>Beaver Hills</i>	A-misk-wā-chī	Cha-ba-hē-i
<i>Bear</i> "	Mus-kwā-chī-si	O-zin-za-hen

INDIAN NAMES OF PLACES.—*Continued.*

ENGLISH.	CREE (Ni-hi-a-wē').	STONEY (As-sin-pwā-tis)
<i>Castle Mountain</i>	O-mask-wē-oo As-sin-wā ti (Queen Mountain.)	
<i>Swampy Hill</i> (east of Raven River).....	Mus-keg-wāti	Wa-ku-ni-a-ha
<i>Hill east of Little Red Deer River</i>.....	.....	Chow-o-bo-o-zin [ba-ha am-
<i>Little Hill</i>.....	.....	Ba-how-oo-dan
<i>Blackfoot Hills</i>	Ah-as-thi-nioo-wā-chi.....	
<i>Two Big</i> "	Nis-wa kis-pa-tin-ak.....	
<i>Frenchman's Butte</i>	We-mis-ti-koo-shē-we-cha-ka-tin-ow	
<i>Moose Hills</i>	Moos-wa-chi	
<i>Nose Hill</i>	Os-ke-wun-ā-chio	
<i>Cypress Hills</i>	Mi-na-ti-kak or Ne-a-ti-kak.....	Pa-ha-toonga
<i>Little Beaver Hills</i>	Pikh-tow A-misk-wā-chi.....	
<i>Pretty Hill</i>	Ka-mī-wa-sit Is-pa-tin-ow.....	
<i>Peace Hills</i>	Wi-ta-ski-oo Cha-ka-tin-ow.....	
<i>Rocky Mtn. House</i>	Kai-as As-sin-wāti Was-kā'hīgan	Ti-shī-a
<i>Calgary</i>	O-toos-kwa-nik (Elbow House.)	
<i>Edmonton</i>	A-misk-wā-chi " " " " " " (Beaver Hills House.)	Ti-tung-a
<i>Fort Saskatchewan</i>	Sī-mā'-gan-is (Soldiers House.)	
<i>Fort Pitt</i>	Was-kā-ha-gan-is..... (The Little House.)	