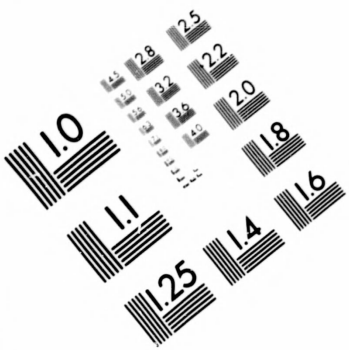

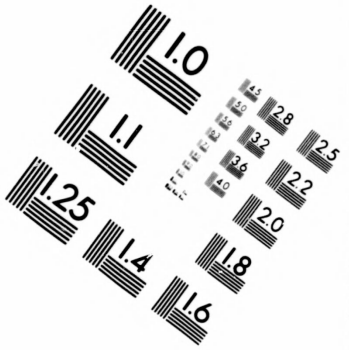

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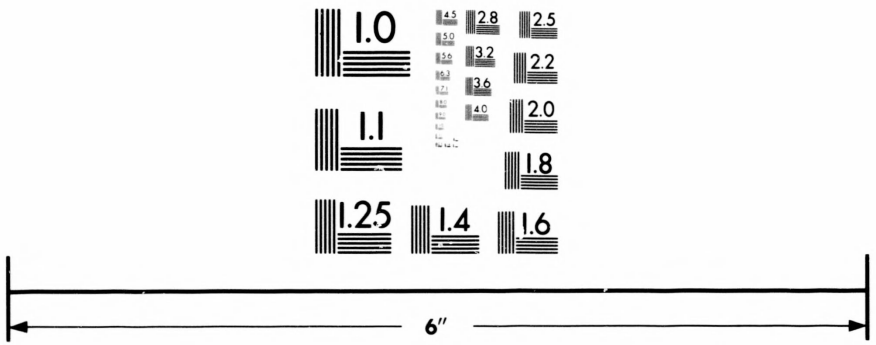

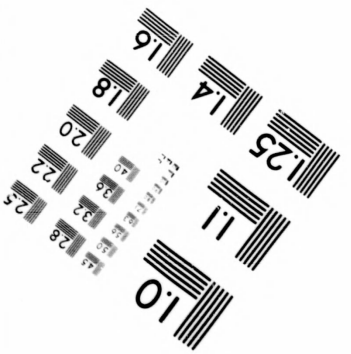

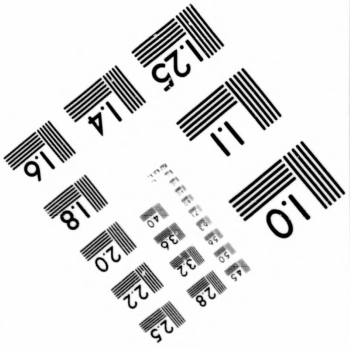

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GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA
ALFRED R. C. SELWYN, LL.D., F.R.S., DIRECTOR.

REPORT

ON PART OF THE

BASIN OF THE

ATHABASCA RIVER,

NORTH-WEST TERRITORY.

BY

ROBERT BELL, M.D., LL.D., C.E., F.G.S., F.R.S., CAN.

1882-3.

PUBLISHED BY AUTHORITY OF PARLIAMENT.

MONTREAL.
DAWSON BROTHERS.
1884.

A. R. C. SELWYN, LL.D., F.R.S., &c.,

Director Geological and Natural History Survey of Canada.

SIR,

I have the honor to submit the annexed report on the geology and topography of a part of the basin of the Athabasca River and the adjacent territory to the south and east of it; also the accompanying map illustrating the report. This map having been constructed since I had the honor of submitting my report * on the region referred to, in December, 1882, I have been able to describe the geology, &c., more fully and minutely than was possible at that time. The map, which is on a scale of eight miles to an inch, is entirely original, and it forms part of a large sheet, on the same scale, constructed by Mr. A. S. Cochrane, showing his own track-surveys as far east as Reindeer Lake. Lake Athabasca and the Clearwater River, as represented on this map, are from Mr. Cochrane's track-surveys, all the rest of the topography being from my own.

I have the honor to be,

Sir,

Your obedient servant,

ROBERT BELL.

OTTAWA, May, 1884.

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* On the 16th January, 1883, I received the usual summary Report of the season tions from Dr. Bell. This was referred to in my report to the Minister, and also pages 1(eological Survey Report for 1880-81-82. The present report was submitted to me in type in nber, 1884. A. R. C. S. 27th Dec., 1884.

REPORT

ON

PART OF THE BASIN OF THE

ATHABASCA RIVER,

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BY

ROBERT BELL, M.D., LL.D., C.E., F.G.S., F.R.S., CAN.

The principal object of the exploration of 1882 was to investigate the geology of the heretofore unexplored portion of the Athabasca River between the junction of the Lac la Biche River and the Clearwater, but my instructions also directed me to examine more carefully than had hitherto been done the relations of the rocks of the river below the latter stream, especially with reference to the mode of occurrence of petroleum and asphalt. Track-surveys were to be made of the routes travelled over, and, as usual, observations were to be noted in regard to geographical facts, surface geology, soil, climate, agriculture, natural history, etc. It was supposed that a canoe-route existed between the southern part of Lake Athabasca and Isle à la Crosse Lake, and, in coming home, I was to have followed it and ascertained something of the nature of the extensive and unknown region lying between the former lake and the upper waters of the Churchill River. It was found, however, that the supposed route was not known to exist, and I therefore returned by the Clearwater River, the Long Portage, Methy, Buffalo and Clear Lakes. The interim report furnished soon after I reached Ottawa gave an account of the mode in which I had endeavoured to carry out the above instructions, including a narrative of the journey to and from the most distant point reached, with dates of arrival at the principal points and other details. It also contained an epitome of the geological results, more particularly in reference to the petroleum and asphalt. A map has since been prepared by Mr. A. S. Cochrane, showing my track-surveys in a connected manner along with those made by Mr. Cochrane the previous

Region to be explored.

Instructions.

Interim report.

Map.

year. This enables me now to give distances and directions and the positions of localities with sufficient precision for permanent reference, and, in connection with these topographical features, I am enabled to furnish the geological description with tolerable accuracy as to geographical details. A portion of this map on a scale of sixteen miles to an inch accompanies this report. I was assisted in the field-work by Mr. A. C. Lawson, B.A., who always carried out my instructions with intelligence and energy. From Winnipeg we proceeded by the Canadian Pacific Railway to the end of the track, and thence with horses and buckboards, by way of Forts Qu'Appelle Carleton and Pitt, to Lac la Biche, the distance by the trails followed being about 770 miles. From this lake I continued my journey northward by canoe, Mr. Lawson being sent with the horses by way of Carleton to Green Lake, where he was to meet me on my arrival from Isle à la Crosse.

Route travelled.

Track-surveys made.

A track-survey was first made of Lac la Biche itself, and then of La Biche River, showing every bend in its entire length. A similar survey of the Athabasca was carefully made, all the way from the junction of La Biche River to its mouth in Athabasca Lake, a distance of about 270 miles in a straight line, or 380 following the sinuosities of the river. Throughout the whole of this long stretch, the rocks proved to be of much geological interest, and they will be fully described further on. A cursory examination was next made of the rocks of the western part of Athabasca Lake. Our knowlege of the geography of the delta of the Athabasca was added to by track-surveys on the return journey. A survey of the same kind was carefully made from Methy or Long Portage, through the various lakes and rivers followed, to Isle à la Crosse, and thence by the Beaver River to Green Lake, which was also mapped, the whole distance in a straight line being 195 miles, or 245 miles following the courses of the rivers and lakes. Mr. Lawson having arrived with the horses at Green Lake, we proceeded thence by Fort Carleton, Prince Albert and the Touchwood Hills to Troy, on the Canadian Pacific railway. The distance thus travelled was about 355 miles, measured in straight lines between the Hudson's Bay Company's posts, but about 470 following the courses of the trails. The distance actually travelled in going out and returning would, therefore, be as follows :—

Distances.

	MILES.
From the end of the C. P. R. track to Lac la Biche	770
From Lac la Biche to Fort Chipewyan	380
From Fort Chipewyan to Green Lake, by the Methy or Long Portage	520
From Green Lake to Troy, on the C. P. R.	470
Total distance by horses and canoes	2,140

The distance travelled by rail from Ottawa in the spring and returning in the autumn amounted to about 3,460 miles, so that the total distance covered during the season was about 5,600 miles.

Geological Description.

Geological description.

No rocks older than the drift were seen *in situ* before reaching the Biche River, and I shall therefore begin my geological description with this stream, reserving my notes on the drift for a subsequent part of the report. The Biche River leaves the western extremity of Lac la Biche, and flows in three stretches in the form of the letter Z, having an aggregate length in three straight lines of forty-five miles. The upper and central courses flow through a very marshy country. The general course of the latter is north, but both it and the third or lowest stretch are very crooked. The latter is full of shallow rapids over pebbles and cobble-stones. According to my barometrical observations the level of Lac la Biche is 186 feet over that of the Athabasca River at the junction of the Biche, and 126 feet of this fall takes place in the last stretch of the river. In some places in this stretch the banks of the river, which are mostly of clay, are fifty feet in height. Small sections of rocks *in situ* occur along this part of the stream, which are quite similar to the Cretaceous strata seen not far off on the Athabasca. They consist of dark drab and indigo-colored marls and shales, with nodules and thin layers of clay-ironstone, lying quite horizontally.

Biche River.

The water of the Athabasca River is more muddy than that of the Biche. Its breadth at the junction of the two streams is from 150 to 200 yards, and it varies but little all the way to the Clearwater, below which it becomes considerably wider. From the Biche River to Point la Biche the general course of the river is N. 8° E (ast.), and the distance 88 miles, and from this point to the Clearwater the general course is N. 70° E. and the distance 55 miles. The following are the distances, in straight lines, of the principal features in the former stretch from the junction of the Biche River:—Quito River, from the west, 8 miles; Mississtiquaio-sipisis or Big-mouth Brook, from the east, 22 miles; Shaitaik or Pelican River, from the west, 52 miles; House River, from the east, 74 miles; the Grand Rapid, 82 miles.

Athabasca River.

Branches.

Between the Biche River and the Grand Rapid the Athabasca has a smooth, uniform current of two to three miles an hour, and above the Biche the same character is said to extend up to the Athabasca Landing. Frequent soundings were taken in the middle of the river from the Big-mouth Brook to House River, on the 27th and 28th of August, and the depth was found to vary from 12 to 22 feet, the average being about 15 feet. The water was at about a medium height at this season.

Depth of the river.

Character of river and banks.

From the Biche to the Pelican River the Athabasca flows between sloping banks from 50 to 150 feet, and at a few points 200 feet in height, the general elevation gradually increasing in descending the stream. The bed of the river is probably fully 200 feet below the general level of the flat country on either side, but the full height of the banks is seldom seen from the river. The sloping banks are partly wooded and partly bare, owing to the sliding of the clayey strata of which they are composed. The timber consists of spruce, balsam, rough-barked poplar, aspen, and white birch. The beach, and apparently also the bottom of the river, are paved with cobble-stones and small well-rounded boulders, consisting mostly of quartzite and gneiss, all packed tightly together and pressed down to an even surface by the drifting ice in spring. This natural pavement often shows scratches parallel to the course of the river, which have been caused by the passing ice.

Geology of banks.

Throughout the above distance the banks consist of dark clayey Cretaceous marls, having a general horizontal attitude, but often appearing to dip at various angles, owing to the sliding of large masses on the slopes. Along the edges of this part of the river numerous large

Concretions.

concretions are met with, which are evidently derived from the marls. They are mostly tortoise-shaped and are often six or eight feet in their greatest diameter. Sometimes smaller concretions are attached to the large ones. When broken they are found to consist of a drab-colored calcareo-ferruginous argillite. The surface of these concretions often presents a reticulated appearance, being divided by veins of yellow calcspar into five or six-sided spaces. A highly crystalline mass of this mineral, or a hollow space lined with it, is often found in their centres. Occasionally the concretion consists of a mere shell of the compact ferruginous argillite, divided into sections by the calcspar veins, and either hollow in the centre or more or less filled up with crystalline calcspar. Besides these large concretions there are numer-

Ironstone, gypsum and pyrites.

ous nodules of clay-ironstone, and in some places crystals of gypsum were observed in the dark-colored marls. On the east side of the river, four miles below the Big-mouth Brook, in a cliff of dark marl thirty feet high, a layer of fine crystals and crystalline aggregates of

Fossils.

iron pyrites was found near the water's edge. Fossils are rare in the marly strata along this section of the river, a small species of Ostrea being the only one found *in situ*. Fragments of fossil wood, which have, no doubt, been derived from the marls, were not uncommon on the surface. On the west side, just below the mouth of the

Ochre.

Pelican River, a considerable deposit of brown ochre was noticed on top of a bank of drift.

From Pelican to House River, a distance of 22 miles in a straight

line, the Athabasca has about the same character as above, flowing smoothly between sloping banks, about 100 feet in height. At first they consist almost entirely of the dark, indigo-colored marls, with a few lighter layers, still quite horizontal, but soon a very soft-grey sandstone, the weathered surface of which has a light, yellowish-grey color, shows itself at the foot of the bank on either side, and as we descend the stream it appears to become constantly higher, owing to the fact that the bed of the river itself is gradually sinking into the strata at an average rate of about three and a half feet in the mile, measured in a straight line. At two miles below the Pelican River, the east bank shows 100 feet of blackish marls with lighter marls toward the top, underlaid by 10 feet of the soft-grey sandstone. At three miles the sandstone at the base has increased to 20 feet; at four miles, to 25 feet, and at five miles to 40 feet, with 60 feet of the dark marls above it; but in this vicinity the strata have a slight dip to the south-eastward. The sandy strata are interstratified with numerous dark shaly layers. For about four miles in the central part of the above 22 miles, the sandstone forming the lower part of the banks has an almost uniform thickness of 50 feet and is interstratified with some blackish marly bands. On the west bank at 18 miles below Pelican, and four miles above House River the following approximate ascending section occurs:—

Soft sandstone.

Marls.

Section.

	FEET.
Very soft or slightly coherent, grey sandstone	40
Dark, indigo-colored marl	20
Soft, light-grey sandstone	15
Dark, indigo-colored marl	25
Drift to the top of the bank	20
	120

Here there is a slight dip to the south-south-westward. A similar section is exposed, also on the west side, two miles further down, or within two miles of House River. In the above portion of the Athabasca River, the sandstones are so incoherent that they seldom form perpendicular cliffs. Only certain portions of the strata appear to be able to withstand the weather for any great length of time.

From House River to the Grand Rapid, the distance is ten miles. For a few miles before reaching the rapid the river is flanked on both sides by cliffs about 40 feet high, of soft, fine-grained, bluish-grey sandstone, weathering yellowish-grey, with patches of a lemon-color. Grand Rapid is the principal obstruction to the navigation of the Athabasca. The rapid is about half a mile in length, with a fall of twenty to thirty feet. The canoe portage trail, about three quarters of a mile long, is on the right side, but the boat portage passes over the larger island. The

Soft sandstone.

Grand Rapid.

river is here divided by two islands, but the greater part of the water follows one channel, down which scows laden with the boilers and machinery of a steamboat to be built for the Hudson's Bay Company, at Fort Chipewyan, had been successfully run a short time before we passed. The lower beds above the rapids contain some tortoise-shaped concretions, and indurated, lenticular patches which appear to differ from the rest of the sandstone only in their greater hardness, and containing a little carbonate of lime. Several of these masses, which had been split open, were observed to contain fragments of fossil wood, of a dark brown color, but weathering white and showing the ligneous structure very distinctly. Some of the concretions have been formed around aggregations of sticks and vegetable debris. One piece of the fossil wood, embedded in sandstone, was found to be six feet long, and 18 by 14 inches in diameter. Seams of carbonaceous matter, two to three inches thick, occur in the cliff on the right-hand side, and along with them are thin layers of fine conglomerate, consisting of small, highly-polished pebbles, from the size of a number 4 shot to that of beans, of green, olive and black chert and white quartz. In some parts these glossy little pebbles are scattered through the sandstone. On the beach at the head of the rapids, fragments of lignite, and of bright-red burnt marl, like fine-grained brick, were found, and at the foot of the rapid many fragments of blackened manganiferous and ordinary clay iron-stone, apparently derived from the sandstone. At the Grand Rapid the bed of the river breaks down into a band of sandstone, which is conspicuous for a long distance below, owing to its being more or less thickly studded with spherical concretions differing from the matrix in containing some argillaceous matter. Towards the foot of the rapid great numbers of these boulder-like concretions are heaped in the bed of the river and are remarkable for their prevailing spherical form. The left bank of the river at the foot of the rapid presents the following section, in descending order, the figures being only approximate :—

Fossil wood.

Small polished pebbles.

Spherical concretions.

Section.

	FEET.
1. Soft, grey, fine, homogeneous sandstone, studded with spherical concretions of a more argillaceous character than the matrix. They vary from 1 foot to 6 feet in diameter, the average being about 3 feet	20
2. Soft, fine, homogeneous, grey sandstone, without visible lines of stratification	25
3. Marly arenaceous layer	4
4. Soft, fine, homogeneous-grey sandstone like	20
5. Dark, aranaceous marl	30
6. Soft, friable, grey sandstone, weathering light yellowish-grey, and forming a perpendicular cliff	25
7. Dark marl on top of bank	15
	139

From a sketch by Dr. Bell, 1882.

Geological Survey of Canada.

GRAND RAPIDS, ATHABASCA RIVER, LOOKING SOUTHWARD OR UP STREAM.

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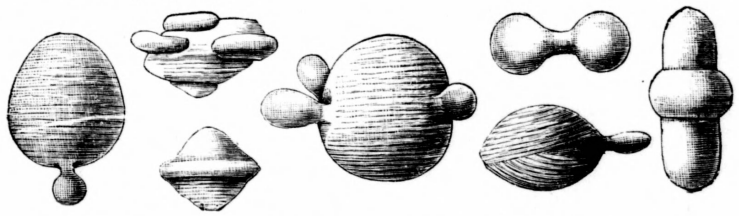
Below the Grand Rapid the concretionary band forms a conspicuous feature in the cliffs along the river for a distance of over thirty miles, gradually rising higher above the water. On the right side of the river at twelve miles in a straight line below the foot of the larger island in the Grand Rapid, where the bank is over 100 feet high, the top of this band is just below the middle line of the cliff, or about 50 feet over the water, indicating a fall of 4.16 feet per mile in the river, assuming the strata to be perfectly horizontal, and this agreed with the difference of level as determined by the barometer. On the left side of the river, between the Rapide Milieu and the Rapide Pas-de-Bout, at a distance of 20 miles in a straight line, or about 40 by the river (from Grand Rapid), the bank is about 300 feet high, and the top of the concretionary band appeared to be about 200 feet over the water, indicating on the same assumption an average fall of 6.9 feet per mile, in a straight course, or 5 by the river.

Concretionary band of sandstone.

Rate of descent in the river.

Leaving the foot of the larger island in the Grand Rapid the river continues broken for a mile and a-half, the descent in this distance amounting to 36 feet, as indicated by the barometer, but below this the water is smooth for more than fifteen miles. For several miles from the above island a bank of soft, grey, friable sandstone, about 90 feet high, continues down the left side of the river. The concretionary band forms a cliff along the edge of the water, having a uniform height of about 20 feet. The concretions are piled thickly along the right side of the stream. Many of them are perfectly spherical, but the largest ones are flattened. Some of the latter are 20 feet in their greatest diameter while many would average 8 and 10 feet. The lines of stratification of the sandstone run through some of the concretions, causing them to split most readily in that direction, while others break with equal facility in any direction. In some parts of the sandstone, the concretions or nodules (as the smaller ones might be called) are so closely crowded together as to almost touch each other. Some are widely and others closely reticulated on the surface, but most of them are smooth. A few of the more characteristic forms are represented in the accompanying cut.

Large concretions.



CONCRETIONS IN CRETACEOUS SANDSTONES AND MARLS, FROM TWO TO TEN FEET IN DIAMETER.

Great Bend.

Pointe la Biche is the name given to the Great Bend of the Athabasca six miles below Grand Rapid, or 88 in a straight line below the junction of the Biche River. Here, as before stated, the general course of the river changes from N. 8° E (ast.) to N. 70° E(ast.), on which it now runs for 55 miles till it is joined by the Clearwater from the right. As Pointe la Biche, or the Great Bend, will be used for reference in stating the directions of localities further down the river, the number of miles in straight lines to the principal points may be here given for convenience :—

Distances from the Great Bend

	MILES.
Little Buffalo River, from the left	7
Burnt Rapid	11
Petite Rivière Bouffante, from the right	21
Drowned Rapid	25
Rapide Milieu	27
Rapide Pas-de-Bout	30
Crooked Rapid	34
Isle la Biche	36
Cascade Rapid	39
Mountain Rapid	48
Fort McMurray at the junction of the Clearwater	55

The banks on both sides of the river at the Great Bend are from 170 to 180 feet in height, and consist principally of soft sandstones. Beds

Lignite.

of lignite are seen towards the top of the cliff, on the left side, for about two miles, at this locality. One of these, four feet in thickness, which occurs just at the Great Bend was examined. Its position is 155 feet above the level of the river, and twenty below the top of the cliff. The underlying strata consist of homogeneous fine grey sandstone, with some interstratified carbonaceous layers, a few inches thick, while the twenty feet above it consist of shaly and thin-bedded sandstones. The lignite itself consists of alternating shaly and solid laminæ with shining fracture. Some parts of the bed are entirely shaly and others are sandy. It also holds calcspar and yellow ochre, so that its general quality is poor. Two miles below the Great Bend the cliff on the left is 170 feet high, and consists of five or six alternating bands of homogeneous and distinctly stratified grey sandstones. A band of thirty feet, about one-third of the distance from the bottom, is much darker

Sandstone pillars.

than the rest. A portion of the band at this locality is weathered into pillars, one of which has a fantastic form. On the same side of the river, at five miles from the Great Bend, or two above little Buffalo River, a seam of lignite, from two to three feet thick, runs along horizontally near the top of the sandstone cliff, which is 100 feet in height. A smaller seam was noted two miles further up. Shaly and marly drab sandstones occur along the edge of the river between this locality and the last mentioned river.

On the upper side of the mouth of the Little Buffalo River the water of the Athabasca, near the shore, is much disturbed, or, as the natives say, it "boils," with the bubbles of gas which rise very thickly and rapidly from the bottom, and are probably due to the existence of a seam of lignite under the bed of the river. At and just below this tributary, the river makes a westward bend, the sandstone cliff on the left forming a great amphitheatre 200 feet high. The cliff on the opposite side is called Point Brulé, and is equally high. It is shaly or marly towards the base; the concretionary band, which is here thirty feet thick, occurs at about one-third of the height of the cliff, the rest of which consists of the yellow-weathering grey sandstone. Coarse shingle and rounded boulders of the drift period rest on top of this cliff. Three miles below the Little Buffalo River and on the right side of the stream, a seam of impure lignite, six feet thick, occurs near the top of the cliff, which is rather more than 100 feet high. This place is twelve miles in a straight line from the Grand Rapid, and, as already mentioned, the top of the concretionary band is here about fifty feet over the water. Two miles further down, and on the same side, a seam of lignite, from a foot to two feet thick, appears in the cliff on top of about 100 feet of sandstone, and overlaid by about ten feet of marl.

Bubbling gas. High cliffs. Lignite. Lignite.

At the Burnt Rapid, where the descent is about eight feet, the cañon of the river looks narrower and deeper than above. Near the edge of the water at this rapid there are some beds of brittle, light drab-colored ironstone and others of somewhat calcareous, green sandstone, containing shells of Cretaceous age, which will be again referred to further on. It also holds many large and small fragments of dark silicified wood, which weather white. They consist of stumps, broken logs, splinters, and round sticks. Fragments of lignite occur along the shore. Angular masses of conglomerate, which appear to be derived from the bed of the river, are also met with at this locality. The pebbles of the conglomerate, which are small, consist of green, black, drab, and white chert and white quartz, and have highly polished surfaces. It also contains pieces of a peculiar ironstone, exactly like that of the Manitounik Islands on the east side of Hudson's Bay.

Burnt Rapid. Cretaceous fossils.

Two miles below the Burnt Rapid the cliff on the right side is 200 feet high, in four terraces or steps of about fifty feet each. The first, or lowest, consists of soft drab sandy marl, the second, of the yellow-weathering, concretion-bearing band; the third, of soft grey homogeneous sandstone. (On the opposite side of the river the band corresponding with the last-mentioned has a thin seam of lignite near the top.) The fourth or top step consists of very soft grey homogeneous sandstone, weathering yellow, which occupies the lower two-

Terraced cliff. Lignite.

Pointe Terre Brulé.

thirds, while the upper third of the cliff consists of drift. At Pointe Terre Brulé on the right side, five miles below Burnt Rapid, and six above Petite Rivière Bouffante, the bank is 200 feet high in three steps, the first or lowest consisting of dark drab finely arenaceous marl; the second, of the concretion-bearing bed, and the third, of homogeneous grey sandstone in the lower half and stratified sandstone in the upper.

Drowned Rapid.

Rapids begin a mile and a-half below the Petite Rivière Bouffante, and continue at short intervals all the way to the junction of the Clearwater, the average fall in this part of the river being from five to ten feet in the mile. At the Drowned Rapid, four miles below the last named river, some fossils were found in the harder arenaceous beds. Upon these, and those found at the Burnt Rapid, Mr. Whiteaves reports as follows:—(1) Fossil wood, apparently coniferous; (2) an *Ammonitoid*, like *Olcostephanus* or *Haploceras*, a species with a comparatively simple sutural line; (3) a small gasteropod, like *Cinulia*; (4) a *Tellina* or *Thracia*; (5) a *Venus* or *Cyprina*; (6) a *Protocardium*; (7) a *Nucula*; (8) an aviculoid shell, probably *Inoceramus*; (9) a *Pecten* and some other lamellibranchiate bivalves. These fossils evidently belong to the Cretaceous system. They are tolerably well preserved, but most of the specimens collected are broken, and are not sufficiently perfect to determine the species with any certainty.

Black petroleum-bearing sandstone.

At the Drowned Rapid a black petroleum-bearing fine-grained sandstone first makes its appearance, and becomes abundant and conspicuous henceforward nearly to the delta of the river or within a short distance of Athabasca Lake. It underlies all the strata heretofore described, and further down the river it was found to have a thickness of 200 feet. Only ten feet are exposed at Drowned Rapid, but this increases to twelve at the top and fifteen at the bottom of the Rapide Milieu, and to forty feet at the Rapide Pas-de-Bout. The blackened bed at the Drowned Rapid appears to represent the highest of the petroleum-bearing strata so largely developed further down. The overlying marls, which are probably the means of preventing the petroleum in any quantity from rising higher in these rocks, also contain a little of the oil and yield its characteristic odor. The petroleum-impregnated marl, which is dark, unctuous, and glossy, throws off the water, or allows it to pass unabsorbed through any openings which may exist. "Mud" of this kind was used to cover a roof at Fort McMurray, after the usual fashion adopted in the country, but it was found to allow the rain to pass so freely through that it became necessary to replace it by clay of another kind. It is possible that the indigo color or other dark tints of some of the Cretaceous marls higher up in the series may be due to traces of petroleum.

Petroleum-impregnated marl.

Slaty cleavage.

The fine-grained marly sandstone, blackened by petroleum at the

Drowned Rapid, has a strong cleavage, the planes of which run N. 35° E., and underlie to the north-westward at an angle of 20° from the perpendicular. It is divided also by horizontal planes which probably represent the bedding. At a temperature of 60° Fahr. the mass is sufficiently plastic to bend considerably before breaking. When cut with a knife the shavings or chips curl up like those of hard soap. When worked in the hand it becomes softened, and may be moulded like putty, and is quite as brittle. In a fire of wood it soon ignites, burning for some time with a smoky flame, and then falling to powder, which floats if thrown into cold water. If a piece of it be immersed in a hot state it will not part with the oil, but repels the water strongly.

Properties of petroleum-bearing sandstone.

The Rapide Milieu occurs at two miles below the Drowned Rapid, and the Rapide Pas-de-Bout at three miles further. Between these two, as already mentioned, the top of the concretionary band, which is about fifty feet thick, has gained an elevation of 200 feet above the river in a bank about 300 feet high. At the Rapide Milieu a split sandstone concretion was observed on the right side of the river, which measured twenty-five feet in diameter on the surface of the dividing plane. Along the right side of the Rapide Pas-de-Bout the black fine-grained marly petroleum-bearing sandstone forms a steep bank forty feet high. In order to gain a foothold in lowering our canoe past the rapid it was necessary to chop numerous notches in the face of this bank, and it was observed that the tough pitchy mass had no perceptible effect in blunting the axes, so that the fine particles of sand, of which it is principally composed, must have been free to yield before the edge. At some places where there appeared to be an excess of asphalt, the bank had softened in the sun's heat and flowed down, forming large pitchy masses at the bottom. About a mile above the narrow point at the Crooked Rapid, the black petroleum-bearing strata have a slight dip to the south-west on the left, and to the north-east on the right side, while on the point itself they dip south-east, at an angle of 10° to 15° in the lower part of the section, which consists of sixty feet of sand saturated with petroleum, but they are perfectly horizontal in the upper part, which is formed of about sixty feet of sandy marls with petroleum, thus showing a local want of conformability.

Highbank.

Flowing asphalt.

Local unconformability.

On the upper or south-west side of this point the first, of the Devonian rocks are seen at the water's edge. They consist of a few feet of earthy, bluish-grey crumbling or "lumpy" limestone, with a solid bed of the same color, a foot thick at the top. The stratification is as level as the surface of the water, so that the overlying beds of the blackened Cretaceous sandstone rest upon them at the above-mentioned angle of 10° to 15°. This, however, is only local, for in most cases further down the river, where the contact is frequently seen, both

First Devonian rocks.

rocks are horizontal, notwithstanding the great space in geological time which separates them. The whole of the 120 feet of fine sandy strata resting on the limestone on the upper side of the Crooked Rapid is more or less impregnated with petroleum. A slight incrustation of salt was seen on these rocks in some parts of the steep bank at this locality. They are capped by about thirty feet of drift. The whole height of the bank was found by barometer to be 153 feet.

Estimate of strata.

Having now reached the base of the Cretaceous rocks on this part of the Athabasca, an estimate may be given, as follows, of the total thickness of these strata in descending order, between Lac la Biche and Crooked Rapid :

	FEET.
Clayey marls, mostly indigo-colored, holding thin layers and tortoise-shaped concretions of impure clay-ironstone. These strata form the banks from the Biche to the Pelican River.	200
Arenaceous marls and homogeneous fine-grained grey sandstones in the banks from Pelican River to the foot of Grand Rapid	170
Bands of grey sandstone, studded with concretions, which are mostly spherical, and of large size, from 30 to.....	50
Marls, mostly arenaceous, grey, drab, &c.....	140
Fine sandy strata, mostly blackened by petroleum.....	200
	760

The fall in Crooked Rapid and Rock Rapid, just below it, amounts to about thirty feet. The portage trail which crosses the narrowest part of the point at the Crooked Rapid is 320 paces in length. At the foot of the portage is a cliff at the river's edge, exposing seventeen feet of perfectly flat, crumbling or "lumpy" drab grey limestone, the interstices between the lumps, which are small, being occupied by argillaceous material. The harder portions of the rock are full of broken fragments of brachiopod shells and small encrinal columns, which were also abundant in the low ledge of the same rock, at the upper end of the portage. The looser beds hold *Atrypa reticularis* and a small *Orthis*. At ten feet from the top of the section a hard bed, six inches thick, produces a projecting ledge or terrace, which runs along the bank of the river for several hundred yards. The surface of this bed is thrown into a succession of little rounded ridges, about three inches high, at regular intervals, of three feet apart. The ridges run E. N. E. and W. S. W. (mag.) The surface of this bed is covered with fucoids, which are also abundant in the rest of the section. It also holds a few small rounded pebbles.

Limestone.

Section.

Opposite the foot of the Crooked Rapid portage, or on the left side of the river, the following approximate ascending section occurs :—

	FEET.
Devonian limestone, like that just described	15
Petroleum-bearing fine sand, not so thoroughly saturated with the oil as further up the river	90
Soft, incoherent, greyish sandy marls	135
Drift	40
	280

On the left side, opposite to Isle la Biche, the petroleum sand is 50 feet thick, but apparently not so rich as usual in the oil. The limestone has here sunk to near the level of the river, and henceforward all the way to the Cascade Rapid it keeps an elevation of only 2 to 4 feet over the water, but the marls increase in thickness, and their bedding forms a small angle with the level surface of the limestone.

200 feet of petroleum strata.

On the left side of the river, abont mid-way between Isle la Biche and the Cascade Rapid, the sandy petroleum-bearing marls form a bank nearly 200 feet high. They were observed to contain some boulders, or large concretions, but the whole of the section is below the position of the concretionary band, which formed so conspicuous a feature higher up the river, unless it has been let down by a fault.

Unconformability of limestones.

A few feet of the limestones are seen at the foot of the bank on either side of the river, all the way from Crooked Rapid to Fort McMurray, a distance of 20 miles, except at a place four miles below the Cascade Rapid, and another about four miles below Mountain Rapid, where its surface sinks below the level of the water. They generally undulate slightly and are usually planed down to an even surface, so that the petroleum-bearing sand rests unconformably upon them. At a few places, in approaching Fort McMurray, the surface of the limestone is uneven, and covered over by the petroleum strata.

Cascade Rapid.

The river at the Cascade Rapid passes down over two or three broad ledges or steps in the limestone, the descent amounting to 8 or 10 feet. Five or six feet of the same rock are exposed in the left bank of the river.

Conglomerate.

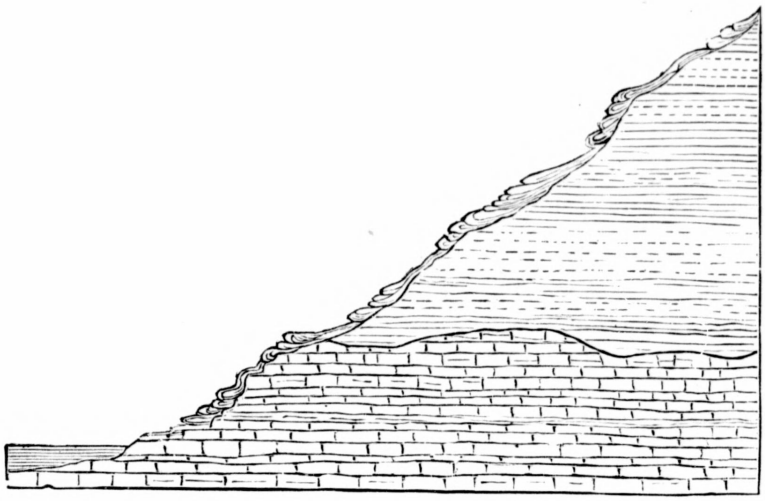
Resting on this is a bed of conglomerate, which varies from a foot to four feet in thickness, made up of rounded pebbles and a few small boulders of quartzite, ironstone, gneiss and limestone. Above it are 80 or 90 feet of the petroleum-bearing sandy marl. In one place a patch of sandy pitch, soft and plastic in the sun's heat, has run out over the limestone of the beach. Three miles below the Cascade Rapid, on the left side, are 80 feet of petroleum strata. The upper 40 feet are marly, of a brown color, and show the lines of stratification, while the lower 40 feet are black, homogeneous and massive, forming an almost perpendicular cliff. This part is evidently quite saturated with the

Tar.

Mountain Rapid.

thickened petroleum. The "tar" runs out of it in many places under the heat of the sun, and in one place it forms a little stream.

On the right side of the river, at the Mountain Rapid, fine, pitchy sand forms a bank 80 to 90 feet high. Eight or nine feet of the limestone are seen under this bank, in the form represented in the cut.

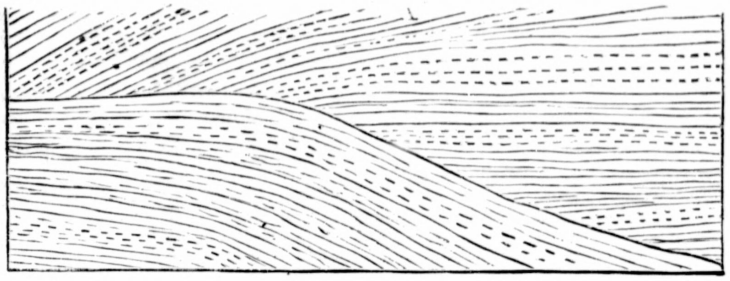


SECTION OF CRETACEOUS SANDSTONE OVERLYING DEVONIAN LIMESTONE UNCONFORMABLY; SHOWING SANDY PITCH FLOWING DOWN THE BANK. ATHABASCA RIVER.

The sandy pitch softens under the sun's heat, and flows in large viscid masses down the face of the bank and over the limestone at its base. Tar and pitch were noticed flowing down the banks in several places between this Rapid and Fort McMurray. A shallow depression has been scooped out of the limestone on the left side, at the foot of the Mountain Rapid, and on the opposite side of the river a low rounded elevation has been left on the denuded surface of the horizontal beds, as seen in cross section. At about one mile below the foot of Mountain Rapid, where the limestone has sunk beneath the level of the river, the petroleum strata, which are upwards of 100 feet thick, dip up stream, at angle of 10° in the upper part of the section, while in the lower part, the layers are nearly horizontal. On the right side opposite the mouth of the Little Fishery River, three miles above Fort McMurray, where about 70 feet of the petroleum sand are exposed in the bank, a want of con-

Little Fishery River.

formity in the strata occurs at about 15 feet above the river, but the line marking this change in the stratification, slopes down to the level of the water, as shown in figure.



SECTION OF CRETACEOUS SANDSTONES SHOWING A LOCAL UNCONFORMABILITY. ATHABASCA RIVER.

The limestone has a height of about 12 feet above the water, on both sides of the river at Horse-trail Creek above Fort McMurray.

It will be observed by the map that the general upward course of the Clearwater River, from its mouth to the Methy Portage, has nearly the same bearing as the downward course of the Athabasca from the Great Bend at Pointe la Biche. The point of junction of the two rivers is known as The Forks. The mouth of the river at Lake Athabasca lies due north from The Forks, the distance being 132 miles, and the stream lies wholly on the west side of a straight line drawn beween these points, but at no great distance from it. On entering the low ground lying to the south of the lake, the river forms a delta, which begins by giving off the Rivière des Embarras, at 112 miles in a straight line from The Forks. The Athabasca flows in a tolerably direct course from The Forks to the head of the Delta. If a straight line be drawn between these points, it will be found to have a bearing of N. 7° W. (ast.) and to cut the river just mid-way between them, the upper half lying close to its west, and the lower half close to its east side. For the first twenty miles, the course of the stream is so direct on this bearing, that it does not vary from it to the extent of its own width, which is about twenty chains. The lower half of the section between The Forks and the head of the delta has many islands, all along, and the average breadth is increased to nearly half a mile. From The Forks to the head of the delta the river is rather shallow, and flows with a swift current, exposing many sand-bars at low water, but from this point the main channel is deeper and narrower, with only a few islands, and no sand-bars. The Rivière des Embarras appears to take less than a third of the water, and below it the principal channel soon turns to the north-east, and at 18

The Forks.

Course of the Athabasca.

Islands.

Rivière des Embarras.

miles in a straight line divides at the Grand Rammon into two almost equal branches, the western one flowing north, for about 11 miles to the open lake. At the end of this distance Fort Chipewyan is seen to the north-westward on the opposite side of the lake at a distance of 10 miles.

Distances from Fort McMurray.

Fort McMurray, at The Forks, is situated on the upper side of the mouth of the Clearwater. According to my track-survey of the river below this point, the following are the distances in straight lines from Fort McMurray to the principal localities, which are here given for convenience of reference :—

	MILES.
Upper Steep-bank River from the right	21
Isolated bluff of Devonian limestone, on right, 35 feet high. A similar bluff on the opposite side of the river. Salt is deposited from water flowing over a bluff of the petroleum strata, half a mile to the eastward of the first-named limestone bluff. The locality is called La Saline	25
From the last locality low cliffs of Devonian limestone are frequent along the right side of the river for 10 miles, or to	35
Lower Steep-bank River on right	30
Little Red River on left	31
Moose River on left	41
Tar River on left	42
Rivière au Calumet on left	47
Pointe-aux-Trembles on right	81
The grave of a former Indian Chief known as The Carcajou's Sleep on the left	90
Head of the delta, or commencement of the Rivière des Embarras on left of main stream	112
The three mouths of the Athabasca, close together, and due north (ast.) of The Forks	132

Steep right bank.

Leaving The Forks, in going down the stream, a bare steep bank skirts the river for many miles on the right side, while on the left there is a level interval of half a mile to a mile in width, on the west side of which a wooded slope rises to a height corresponding with the bank on the right. For the first twelve miles the right bank varies from 100 to 150, and in some places to nearly 200 feet in height, and consists of fine quartz sand saturated with petroleum, which gives it a coaly appearance, when freshly exposed, resting on a few feet of Devonian limestone. The stratification is generally nearly horizontal, but the tendency to cleave across the bedding, as described when these rocks were first met with at the Drowned Rapid (*vide ante*), which sometimes develops itself in the more homogeneous beds, and the lamination of others may have induced former travellers, such as Sir John Richardson and Professor Macoun to call the rocks "bituminous shales"; but, as already stated, they were found to contain fossil wood, lignite and Cretaceous shells. Owing to the black color of the whole mass the fossil wood and the lignite would escape ordinary observation, but they may be found in greater or less quantity when carefully looked for at

Coaly appearance.

Lignite and Cretaceous shells.

almost any locality where these rocks occur. Near the top of the high bank on the right, at twelve miles from Fort McMurray, there is a seam of lignite, apparently three or four feet in thickness. Among the fresh fragments which had fallen from it were some blocks a foot in diameter. Lignite.

Below this point the right bank diminishes in height, but still consists of the black, petroleum-soaked, fine sand until reaching a point fourteen miles below Tar River, or fifty-three miles below Fort McMurray. Further down, banks and hills of loose sand are occasionally seen, on the right side, either overlooking the river or at a short distance back from it. Four miles above Pointe-aux-Trembles the right bank, composed of sand, rises to a height of 60 or 70 feet, and, a little lower down, sand hills 150 feet high are seen on the same side, a short distance back from the river. Similar hills, 70 or 80 feet high, extend at a short distance inland, from six to nine miles below the point just referred to. Further on, banks of reddish, yellowish and light grey sand, about 30 feet high, occur at a few places on the same side to within nine miles of the head of the delta, where the last of them is passed. Banks and hills of sand.

On the west side, as already mentioned, there is a level intervale, nearly a mile wide, between the river and the foot of the main bank, extending for several miles below The Forks. The bank comes close to the river at 18 miles down, and from Tar River, at 42 miles, it follows the side of the stream for a distance of 20 miles. The last bank near the river, on the west side, is 13 miles further down, or at 73 miles, in a straight line, from Fort McMurray; but rising ground was observed a short distance back, opposite to Pointe-aux-Trembles, at 81 miles from the same place. It will, therefore, be observed that the east or right bank of the Athabasca, below The Forks, is the highest, and that it keeps more closely to the river than the other. West bank.

The petroleum-bearing sandy strata, which are so well seen on the east side for the first 53 miles below The Forks, occur only at intervals along the left side of the river. They were noted at the following distances, measured in straight lines from Fort McMurray, namely:—18, 42 (Tar River), 49, 51, 74 and 87 miles (both sides). Almost everywhere along the black banks on the east side the asphaltic sand has softened under the sun's heat and flowed down to the foot of the bank in viscid masses, which appear to contain a rather larger percentage of petroleum than the undisturbed strata. At a temperature of about 60° Fh. the sandy pitch of these flows has the consistence of hard cheese, and when cut or penetrated by a knife it has no tendency to stick to the blade. In some places, however, it is much thinner, and even small pools of oil and thin tar had formed in connection with it. At the Petroleum-bearing strata. Softened asphaltic sand.

ordinary temperature it generally yields only very slightly to the pressure of the foot, but on warm days the men employed in tracking the boat up the river occasionally experienced some inconvenience from their feet sinking into the pitch. If worked in the hand, this pitch, and even the undisturbed petroleum-bearing sand, as already stated, will adhere to the fingers very tenaciously.

Pebbles and boulders in pitch.

In flowing, with a rolling movement, over the beach of the river, the sandy pitch incorporates the pebbles and boulders, which, in some places, become a large proportion of the mixture, and when this is flattened by the pressure of the passing ice it forms a natural asphaltic pavement.

Tar oozing from banks.

During the warm weather, tar, or thin pitch, free from any mixture of sand, oozes out of the banks, as if by pressure, in places where the black strata appear to be supersaturated with the thickened petroleum. This accumulates among the vegetable matter on low ground, and may be collected in considerable quantities. It is possible that the tar also rises in some places by pressure from beneath. It is taken in barrels to the posts of the Hudson's Bay Company and to the mission stations, and after boiling it down so that it will harden on cooling, it is used for paying over boats, roofs, etc. Tar is taken for these purposes near the bank of the river, at points situated at the following distances in straight lines from Fort McMurray, all being on the right side: 19, 33, 36, 40 and 51 miles. Bishop Faraud, of Lac la Biche, informed me that he had seen a large quantity of this tar on an island in the river, which would be about 60 miles below Fort McMurray. At the first of these localities, 19 miles down, the tar is found at 640 paces back from the bank of the river, on ground between 50 and 100 feet above its level and a short distance from the foot of a second bank about 15 feet high. The surface at the place is formed of hardened pitch, overgrown with moss, etc., and more or less mixed with vegetable matter and fine sand. The latter may have been washed down from the bank above mentioned. Sixteen small holes had been broken through this crust, and, at most of them, tar had been extracted from beneath it, with wooden spatulas. The locality at 40 miles down is scarcely a mile above the mouth of Moose River, which enters from the opposite side. Here the tar oozes out with springs of clear water only a few feet above high water mark and 20 or 30 yards out from the foot of a bank of the petroleum-bearing sand 30 or 40 feet high. Both the water and tar are covered with a crust of hardened pitch mixed with moss and other vegetable matter, but which is still plastic enough to yield to the pressure of the foot. Holes are broken through the crust and the fresh tar is collected with wooden spatulas, and placed in barrels for removal. A thick kind of tar is found in holes

Localities of tar.

Crust over tar.

under the clear water, while a thinner variety floats on top of it under the hardened crust.

All along the banks of the Athabasca, in the neighbourhood of the asphaltic deposits, an odor of petroleum, which in this case is not unpleasant, pervades the air, especially in warm weather. Blotches of irridescent oily scum and small patches of petroleum may be seen floating on the water near the edges of the river all the way from The Forks to the mouth, and these occasionally collect together against projecting sticks and logs. The economic value of the petroleum and asphalt of the Athabasca region will be referred to further on. Odor of petroleum.

The yellowish-grey Devonian limestone forms low ledges and bluffs along the foot of the banks of petroleum-bearing sand on the east side, all the way from the Forks to a point six miles below the mouth of the Little Red River, a distance of thirty-seven miles. It is also seen at a number of places on the west side to within three miles of the same distance. The rock is generally thin-bedded and somewhat earthy, with rough surfaces. Devonian limestone.

Some beds of a drab color and containing a considerable percentage of carbonate of iron, in fact approaching the character of clay-iron-stone, were found about four miles below The Forks. Clay iron-stone.

Fossils were collected from the limestones here and there all the way from The Forks to the last exposure on the river. Among them the following have been recognised by Mr. Whiteaves: *Pleurotomaria*, well-preserved casts; a *Bucania*, *Paracyclas elliptica* (Conrad sp.), a *Palæoneilo*, a *Leptodesma*, and two other species of Aviculidæ, ; a *Meristella* or *Athyris;* a *Spirifera*,—like *S. Ziczac* (Hall); *Orthis striatula*, (Schlotheim) or possibly the young of *O. Iowensis* (Hall); *Atrypa reticularis* (Linn), abundant and well preserved; *Strophalosia productoides*; and a small fragment of a Stromatoporid. One of the most singular fossils collected from these rocks is a brachiopod shell, like an *Atrypa*, about three-fourths of an inch long, with a thin smooth and translucent shell, remarkable for having preserved its original colors. It shows eleven rows of distinct brown spots on the dorsal valve, radiating from the beak, and six or seven rows on the ventral valve. Sir John Richardson mentions having also found a fossil in these rocks which had preserved the color of the shell when alive. Instances of this phenomenon are very rare in such ancient rocks. A Cephalopod, like *Gomphoceras* or *Cyrtoceras*, was found in these limestones at Mountain Rapid, higher up the river. Fossils.

The general attitude of the strata is about horizontal; the bedding is however, seldom quite level for any great distance, but undulates slightly in all directions, until it finally disappears under the river, and nothing is seen in the banks but the petroleum-bearing sand and the drift.

Indications of the origin of the petroleum.

The walls of the transverse joints and other spaces in the limestone were frequently observed to be blackened with petroleum, and at a place nearly opposite to the mouth of the Little Red River, some irregular cavities contained inspissated pitch. These limestones were not found to yield petroleum on fresh fracture, although they had occasionally a bituminous smell, but traces of the oil were afterwards found in a bed of limestone on the Clearwater River, which would be much lower down in the formation. There is little doubt but that the vast quantities of somewhat altered petroleum contained in the soft Cretaceous sandstones of the Athabasca region have been derived from the Devonian limestones, immediately underlying them, which are probably very thick.

Petroleum.

Sir John Richardson mentions the occurrence of black pitch or bitumen in patches, and as filling fissures in several places in the limestones of this formation along the Slave and Mackenzie Rivers. Copious springs of liquid petroleum are known to rise out of these limestones in the western part of Great Slave Lake. These have been described by myself from the verbal accounts of officers of the Hudson's Bay Company, in the Journal of the Canadian Institute (Toronto) for 1881, to which the reader is referred for fuller details.

Source of the petroleum.

That the petroleum came from below would be expected in accordance with natural laws, and from the fact that the higher rocks of these regions to the south and west would have been very unlikely to produce any petroleum, even if they had once extended all over this region. Where the contact of the sandy petroleum-bearing strata with the higher Cretaceous rocks was seen at the Drowned Rapid, it was observed that the oil was prevented from passing upward by tenaceous clayey strata. It may occasionally find an upward passage through these confining argillaceous beds, and this would account for the isolated springs or wells of petroleum which are reported as occurring in various parts of the Athabasca-Mackenzie country. The drift resting on the black petroleum-bearing strata was nowhere observed to be impregnated with the oil, showing that it had saturated the Cretaceous strata, probably as a thin liquid, and become altered to its present state long before the glacial period.

Age of petroleum-producing strata.

The supposition that this petroleum has been derived from the Devonian rocks is in harmony with what is known to occur in Gaspé, Western Ontario and the States of Ohio and Pennsylvania.

South shore of Lake Athabasca.

High ground, like the east bank of the river below the Forks, is seen near the shore of Lake Athabasca, to the eastward of the mouth of the river. Very little is known of the southern shore of the lake, as it is but little frequented. Two men were met with, however, who had travelled along it, and from them it was learned that low cliffs and ledges of limestone are to be seen at a few points. On the south side

of the eastern extremity, and on Black Lake further east, Mr. A. S. Cochrane, in 1881, found red sandstone and red sandstone-conglomerate, with rounded pebbles of white quartz. Red sandstone is said to occur at the second fall on the Clearwater above the Methy Portage, and at a distance of about twelve miles from it. Mr. Walter Francklyn informed me that he met with what he supposed to be red sandstone on the Deer's River, by which he travelled from the Churchill River to Cree Lake, the largest sheet of water lying to the south of Athabasca Lake. The boulders about Fort Chipewyan are principally of reddish sandstone, with white quartz pebbles, and reddish-grey quartzite. The south-westward course of the glacial striæ in this neighborhood shews that these boulders came down the lake. The gravel and sand are also chiefly formed of the debris of red sandstone. Red sandstone.

The northern side of Lake Athabasca presents a great contrast to the southern. The latter consists of either low ground, or level plateaus, underlaid by almost horizontal strata, and all clothed with timber, while the northern is formed of rounded hills of Laurentian and Huronian rocks, with little soil, and often denuded of its timber by fire. At Fort Chipewyan, the rock is a red gneiss, strongly banded and ribboned. The average strike is S. 15° W (mag). The islands and points around the western extremity of the lake and at the outlet of Lake Mammawee, are all composed of gneiss. At the latter locality, the average strike of the gneiss, which is mostly red, is S. 8° W (mag). The Huronian series, which Mr. A. S. Cochrane found on the northern side of the lake, about thirty miles north-eastward of Fort Chipewyan, and at three other localities further east on the same side, was not detected around the western extremity of the lake. North side of Lake Athabasca.

On the return journey, as before mentioned, the route followed was that by way of the Clearwater River, and Isle a la Crosse. In ascending the river, the plateau of petroleum-bearing Cretaceous bands which comes out in the east bank of the Athabasca, below The Forks, appears to continue for some miles up the north side. Large masses of the sandy pitch, such as flow down the steep banks of the Athabasca, were found in the bed of the Clearwater river, at 11, 13 and 17 miles above The Forks. Small quantities of petroleum were observed floating on the river up to the last-mentioned point. Clearwater River. Petroleum-bearing rocks.

Devonian limestone, like that of the Athabasca, was observed at intervals along the Clearwater, for the first twelve miles in going up, and again at all the portages, which are five in number, and begin at about two-thirds of the distance from The Forks to the Methy Portage. The empty boats can he towed past all the rapids at these portages except the uppermost. The first is called the Cascade; the second, the Bonne, and the third the Gros Roche. These all follow each other in Devonian limestone. Five portages.

close succession. The fourth, or Pas, is between two and three miles above the Gros Roche, and the fifth, or Terre Blanche, about five and a-half above the Pas. They are all within a space of about nine miles.

Cascade Rapid. Pas Rapid. The rock at the Cascade Rapid is a thickly bedded, hard, yellowish-grey limestone, with a bituminous odor on fresh fracture. At the Pas Rapid, and in the valley of the river above, and to the north of it, much rock is exposed. It consists of a porous or spongy-grey, bituminous limestone. One bed in the vicinity of the rapid was stained with free petroleum. Islands and pillars of the limestone stand in the river at the rapid, and in the sand which covers the bottom of the valley in the neighborhood. In some places the limestone is cavernous, and all the exposures are much decayed and eroded. The valley itself appears to be of pre-glacial origin. It is between 500 and 600 feet deep, and its banks, towards the top, are very steep. In the neighborhood of the rapids they expose bare spots of light-coloured, gravelly-clay. On the north slope of the valley, between the Pas and Terre Blanche Rapids, at about two miles below the latter, a cliff of thickly bedded or massive light-grey limestone was found. It is of a porous character, and the weathered surface shows numerous holes, resembling the burrows of swallows in a sand cliff. A cave has been worn out in one part of the cliff. At the Terre Blanche Rapid, the river passes down amongst the high islands and points of grey limestone, which is much shattered on the surface by the weather, but otherwise it appears to be mostly of a massive character. No fossils were observed in the rocks at any of the rapids, and they appear to belong to a part of the Devonian system, somewhat lower than the fossiliferous beds immediately underlying the Cretaceous further west.

Free petroleum. Sand. Porous limestone. Terre Blanche Rapid.

Mineral springs. Numerous streams of mineral water flow into the Clearwater from springs on the slopes on either side, all the way from The Forks to the rapids. They deposit a bluish-white, flocculent precipitate along their course, and have a slight odor of sulphuretted hydrogen. The most notable group of these springs occurs on the north side, about four miles below the first, or Cascade Rapid, and the locality is known as The Mineral Springs. Here the springs are very copious, issuing from the bank in a number of places, for a space of 300 yards in length. The largest single spring forms a small brook itself, and the addition of these and all the other mineral springs which flow in further down, must increase considerably the soluble salts in the water of the whole river. The uppermost spring of the group is not seen from the river, but flows out among masses of the limestone, and falls into a small brook. From a large spring near the mouth of this brook, five and a-half quarts of the water were taken and boiled down. This yielded 1.36 ounces (avoirdupois) of crude salt, and from one-fifth to one-fourth more ad-

hered to the large kettle, which was used in evaporating the water. Mr. Hoffmann finds this salt to contain potash, soda, magnesia and lime, all in considerable quantity as sulphates, chlorides and carbonates. The water of this spring, (and all the other springs) is very clear and bright, and has a pleasant saline, and slightly alkaline and sulphurous taste. These springs have, no doubt, valuable medicinal properties, and being situated in a picturesque locality, they may at some future time become resorts for invalids, when this part of the North-west Territory shall have been opened up by railways and peopled. The composition of the water is more particularly described in Report MM. by Mr. Hoffmann. Composition of the water.

The Methy, or Long Portage, crosses the height-of-land, which divides the waters flowing into the Arctic Sea, by way of the Mackenzie River, from those flowing into Hudson's Bay by way of the Churchill. It is nearly twelve miles in length, and connects the Clearwater River with the head of the Methy (Dogfish) Lake. The Clearwater, as already stated, runs in a deep valley, excavated principally out of drift, but exposing, towards the bottom, Cretaceous sand with petroleum, Devonian limestone as up far as the rapids, and it is said, red sandstone at the second fall about twelve miles above the Methy Portage. The brink of the bank on the south side, on the portage trail, is a mile and a-half from the Clearwater, and it was found by the barometer to have an elevation of 540 feet above it. The bank here consists of a stiff, pebbly-grey clay. From this point to the Methy Lake, the trail, for the most part, passes over white sand mingled with stones, which are principally fine-grained, white quartzite with some of gneiss. Methy Portage. Deep valley. White quartzite stones.

No geological facts worthy of special notice were ascertained on the journey from Methy Lake to Isle a la Crosse Lake. The latter lake is the meeting place of the waters from all directions, and the surrounding country is low, sandy and swampy. Rocks, *in situ*, were not observed, but a small exposure of limestone is said to exist in a cove on the west side of the arm leading from Clear Lake, a few miles from the Hudson's Bay Company's post. Mr. Walter Francklyn, of this establishment, has sent me a perfect specimen of *Orthis subquadrata* (Hall), which had been found at the lake. This species would indicate the horizon of the Trenton formation or thereabouts. Ile-a-la-Crosse Lake.

The Beaver River, for twenty-five miles from its mouth (in Ile-a-la-Crosse Lake), flows through a flat country, and is filled with long, narrow, marshy islands, which form a singular feature of this part of its course. The soil on either side, like that around Isle-a-la-Crosse Lake, continues sandy and poor until reaching the Grand Rapid, above which a great improvement takes place, and the country generally continues to be much better all the way southward to the North Saskatchewan River. At the Grand Rapid, which is about two miles in length, the bed of the Beaver River.

river is full of boulders, over which the water flows, but in the banks a dark, slate-coloured marl makes its appearance, and although the stratification has been disturbed by the pressure of the ancient glacial ice; it is evidently the rock of the country, and is considered to be the commencement of the Cretaceous area. The change in the nature of the surface deposits, which become clayey from this point southward, would lead to the same conclusion, the direction of the drift having been from the north-eastward.

Cretaceous area begins.

Surface Geology.

Nearly the whole of the country examined during the season being covered by drift or soft Cretaceous rocks, the glacial striæ were seldom seen. At the foot of the Mountain Rapid, on the Athabasca, seven miles above The Forks, these striæ are well seen on a smooth surface of limestone, running S. 80° E. and N. 80° W. (mag.) Near the edge of the water, at the same place, scratches produced on the limestone by the passing of the river ice, run at right angles to the ancient striæ. At Fort Chipewyan, and again at the Roman Catholic Mission, about a mile to the west of it, the striæ are well marked upon the gneiss. Their course varies from S. 55° W. to S. 60° W. (mag.). On the island at the outlet of Lake Mammawee the striæ on the gneiss run S. 55° W. (mag.)

Glacial striæ.

As elsewhere stated, the boulders about Fort Chipewyan are mostly of red sandstone, containing white quartz pebbles. The gravel and sand are also derived from the same sandstone. As this rock is known to occur largely at the east end of the lake and beyond it, and as the course of the glacial striæ corresponds with that of the length of Athabasca Lake, there is no doubt the material of the drift at this locality has been scooped out of the lake basin.

Drift at Fort Chipewyan.

An interesting point in reference to the drift in the North-West Territory is the distribution of quartzite pebbles and boulders, which are always thoroughly rounded, very smooth, and usually the boulders are of small size. In going northward from Fort Pitt to Lac la Biche cobblestones, mostly of hard grey and reddish-grey sandstone or quartzite, become abundant at Gull Lake, between the crossing of the Beaver River and Lac la Biche. Along with these are some of gneiss. Quartzite pebbles and small boulders are met with all along the Athabasca from the Biche River to the Great Bend, being in this section probably the most abundant of the travelled constitutents of the drift. On the Methy Portage the commonest stones consist of a fine-grained quartzite, which is pure white, thus differing from the grey and reddish-grey and banded quartzite of the cobblestones and gravel further west. They are generally also somewhat angular or only partly

Quartzite pebbles and boulders.

rounded, which is another evidence of difference. The uneven surface of some of them are smoothed as if by tne blowing of the sand on which they lie. Here, as everywhere in the country traversed during the season, there is a certain proportion of stones of gneiss. Pebbles and cobblestones of light grey quartzite extended southward on our homeward route for 25 miles south of the southern extremity of Green Lake.

Specimens of quartzite of various shades of grey and one of a deep green color, broken from the rocks *in situ*, were sent me by Captain H. P. Dawson, R.A., from the vicinity of Fort Rae, on the deep northern bay of Great Slave Lake. I have also received frem Mr. G. McTavish a specimen of white quartzite from Marble Island, in the north-western part of Hudson's Bay, which is said to represent a common rock there. The island may have derived its name from the circumstance that this rock bears a close resemblance to white marble. Mr. Roderick Ross, of the Hudson's Bay Company, who has travelled much in the country about Lake Athabasca, informed me that boulders and fragments of a similar rock are to be found all through the country from that lake to Hudson's Bay. The Rev. Father Petitot has brought pebbles of white quartzite from the bed of the main Mackenzie River; and quartzite of various colors have been found in the Rocky Mountains about the head-waters of the South Saskatchewan. Similar rocks may also occur in many regions in the north, north-east and north-west, which have not yet been explored and may not be examined for many years to come. Until we have the means of distinguishing with certainty all the quartzites of this great northern region, the mere occurrence of quartzite *debris* in the drift proves nothing as to its source or origin. Not much information can be derived from the direction of the glacial striæ. At Fort Chipewyan it is S. 55° to 60° W. by compass, or only a few degrees south of true west, and at the Mountain Portage on the Athabasca, seven miles above The Forks, it is S. 80° E. magnetic, or S. 54° E. astronomically, so that these two courses would intersect each other at an angle of upwards of 40°.

Slave Lake.

Marble Island.

Mackenzie River.

Lac la Biche is situated just northward of the Height-of-Land, and it lies in a shallow basin excavated in stratified clay and sandy loam of Post-tertiary age. These deposits appear to extend for many miles in all directions from the lake, and where the country is not too swampy the soil is excellent, as proved at the farms of the Hudson's Bay Company and the Roman Catholic Mission, as well as at the gardens of the numerous half-breed settlers around the lake. On the north-east side of the point between the Hudson's Bay Company's post and the Mission a section of the bank was seen to consist of 8 feet of stratified dark colored clay on top of 25 feet of yellowish-grey, fine, sandy clay.

Basin of Lac la Biche.

Excellent soil.

Composition of shingle.

At the Company's post, which is at the south-east end of the lake, the banks are composed of brownish clay. Here the pebbles of the beach consist principally of grey and reddish-grey quartzite, mostly fine-grained and compact; some are ribboned and translucent, others opaque. There are also pebbles of whitish chert, decomposing silicious material, purplish amygdaloid, in which the spots are small and white, black chert with fine white bands, felspar, gneiss, &c. One pebble of handsome yellow chalcedony was also found. There is here a row of gneiss boulders in the water, a few feet from the present shore, which has probably been formed by the shoving of the ice. Lac la Biche is said to be nowhere more than about twenty feet deep. Its level was

Height of lake.

found by the barometer to be 186 feet above the junction of its outlet with the Athabasca River. Its waters abound in the finest whitefish which supply a large part of the food of the settlers.

Origin of valleys.

The valleys of both the Athabasca and Clearwater, as far as they are excavated in the Cretaceous and Devonian strata, may be of pre-glacial origin. There appears to be no evidence that these rivers themselves removed so large an amount of rock; and drift materials, similar to those of the higher levels, are deposited equally below the more ancient walls. On the east side of the Athabasca, about five miles below the junction of the Pelican River, a large patch of the dark Cretaceous marl from the upper part of the bank has slipped over and rests upon a considerable thickness of shingle. At Pointe Brulé, nearly opposite the mouth of the Little Buffalo River, a considerable quantity of similar shingle and boulders rests on top of the sandstone cliffs about 200 feet high. The banks of the Clearwater, which, except near the mouth, are from 500 to 600 feet high, consist principally of pebbly drift clays, with Cretaceous and Devonian rocks towards the base in some places, as already mentioned. The sandy banks of the Athabasca, towards the head of the delta, have been referred to in describing the river in a previous part of this report.

Economic minerals.

Economic Minerals.

My attention was constantly directed to the discovery of economic minerals and to all the circumstances connected with those already known to exist in the region examined.

Gold.

Gold in the form of fine dust was said to have been found by passing miners and explorers on both the Athabasca and the Clearwater, but I did not succeed in detecting its presence, although it was diligently looked for along both streams.

Iron.

Iron. As stated in the description of the Biche River, nodules and thin interrupted beds of clay-ironstone occur in the dark marls of the lowest stretch. The large concretions of low grade ore of the same

kind which are derived from the indigo-colored marls of the Athabasca, above the Pelican River, have been fully described. Thin beds, containing a considerable percentage of carbonate of iron, were found among the Devonian limestones on this river below the Clearwater, and as clay-ironstone in workable quantities occurs elsewhere in the Devonian rocks, the possibility of finding larger deposits in this region should be kept in view. In 1881 Mr. Cochrane obtained small quantities of red hæmatite at Fond du Lac, on the northern shore of Lake Athabasca, and requested the gentleman in charge to enquire and search for iron ores in larger quantity. In consequence of this, a short time before my arrival at Fort Chipewyan, he had brought to that establishment a large freshly broken specimen of fine magnetic ore, said to have been obtained near the entrance of Black Bay, on the same side of the lake. Clay ironstone. Red hæmatite. Magnetic iron.

Lignite. Seams of lignite, sometimes thick enough to be worked, have already been described as occurring amongst the Cretaceous sandstones and marls on the Athabasca, between the Grand Rapid and the junction of the Clearwater, and a seam three or four feet thick was noticed in the petroleum-bearing sand on the east side, about twelve miles below The Forks. Indications of lignite were also found at other localities in these rocks, but, owing to the general black color, of the banks a seam of the lignite might easily escape observation. Lignite.

Ochre. A considerable patch of reddish ochre, or marl, was observed on the west bank of the Athabasca, about three miles above the Big-mouth Brook, and a deposit of brown ochre, which appeared to be large enough to be of economic value, occurs on the same side on top of a bank of drift about half-a mile below the Pelican River. Ochre.

Clays suitable for brick-making, puddling, etc., were seen in the banks of streams, etc., at various places between Fort Pitt and Lac la Biche, and some of the beds of clay around this lake would answer the same purpose. The stiff, dark-colored marly clays of the Athabasca, between the Biche and the Pelican rivers, where they have been exposed to the action of the weather, would probably make good bricks. Clays.

Marls. The bottom of Lac la Biche, near the outlet, is said to be covered with white shell-marl, and the same substance is reported as occurring in other lakes. A light greenish-blue marl is obtained among the Devonian strata near The Forks of the Athabasca, which is highly prized as a wash for the inside of houses. Marls.

Limestone. Some of the Devonian limestones along the Athabasca would be suitable for burning into lime, and at the rapids of the Clearwater any quantity of a superior quality for this purpose can be obtained. Many of the beds in this neighborhood would make excel- Limestone.

lent building stones. Mr. Cochrane found impure limestones among the Huronian rocks on the north shore of Lake Athabasca.

Moulding sand. *Moulding Sand.* A fine loamy sand, apparently suitable for moulding, was observed at a few points along the Athabasca, between the Grand Rapid and The Forks.

Sand for glass-making. *Sand for Glass-making.* In the valley of the Clearwater, at the Bonne Portage, and again at the Terre Blanche Portage, large quantities of fine pure white sand occur, which, to all appearance, would serve for making good glass. The white sand of the Methy Portage would also answer for the same purpose.

Graphite. *Graphite.* Worn pieces of fine-grained graphite are found on the north shore of Lake Athabasca, near Fond du Lac, and the natives were requested by Mr. Cochrane to try to find it in the solid rock.

Salt. *Salt.* At the locality known as La Saline, about half-a-mile east of the Athabasca and twenty-five miles below The Forks, a white incrustation of salt is deposited from water flowing over a bank of the black petroleum-bearing sand. The salt used in the Athabasca district is, however, brought from Salt River, a small western branch of the Slave River, where it is found of excellent quality on the surface of the ground in crystals about the size of those of Liverpool salt, and is shoveled directly into the bags in which it is transported. Gypsum is said to occur in economic quantities near the salt. The numerous and copious mineral springs along the Clearwater River, which have been already described, are perhaps destined to become of value in the future.

Salt River.

Gypsum.

Petroleum and asphalt. *Petroleum and Asphalt* were the most important substances which came under my notice during the season. Their mode of occurrence along the Athabasca, both above and below The Forks and on the Clearwater, has been described in a previous part of this report. These deposits have been referred to by the earlier travellers, especially Sir John Richardson, who described this part of the Athabasca in 1823; but in those days the science of geology was in its infancy, and no attention had been paid to the geological relations of petroleum, which was not at that time considered of any commercial value. The asphalt and "tar" of the Athabasca region were, therefore, referred to as natural curiosities rather than from any appreciation of their possible future use. Now, however, they may be regarded as of great scientific interest and economic importance, notwithstanding the distance of the locality from present railways. The enormous quantity of asphalt, or thickened petroleum, in such a depth and extent of sand indicates an abundant origin. It is hardly likely that the source from whence it came is exhausted. The whole of the liquid petroleum may have escaped in some parts of the area

below the sandstone, while in others it is probably still imprisoned in great quantities and may be found by boring. The thickened and blackened residue, which now saturates the sand and renders it plastic, has resulted from the escape of the more volatile hydrocarbons and the simultaneous oxidation of those remaining. This itself may have, in the course of time, prevented any further escape of the petroleum from the limestone below. In some places argillaceous beds in the sandstone or amongst the limestones may have held down the oil. The attitude and conditions of the strata are favorable for the accumulation of the oil amongst the limestones themselves, and it is therefore to be expected that productive wells will be found by boring into these rocks along the part of the Athabasca where they may be reached. The petroleum, in regions which have been worked, is believed to be most abundant near the crowns of low anticlinals or domes (as might have been expected), where it has been prevented from escaping upward by impervious strata. It may therefore be found in great quantity where the surface indications are faint. Conspicuous surface indications do not always indicate the largest stores of oil below, since it may have escaped so freely as to have left but little behind. It has been stated that the Devonian limestones along the Athabasca are, on an average, nearly horizontal, but that they undulate slightly or dip locally in various directions. The majority of the dips appear to indicate a tendency to form slight anticlinals and synclinals running in an easterly and westerly direction. The question of the best sites on which to bore for oil would be partly determined by a consideration of these facts. The subterranean accumulations of oil may be expected to be found on the principal anticlinals or domes in the limestones without reference to the attitude of the unconformably overlying Cretaceous sands. A point might be selected on one of these where the surface tar or naptha was least profuse, care being taken to avoid surface water, quicksands, boulders, &c. The indications of petroleum in the Cretaceous sand were wanting, or only slight, at two or three places. One of these might be a promising spot for a trial well, provided it was found that the absence of petroleum was not due to the spot being situated over a synclinal axis in the limestone formation.

Boring.

Petroleum retained.

Anticlinals.

The pitchy sand may itself be found useful for a variety of purposes. When chopped out of the bank in lumps like coal it was found to burn freely with a strong smoky flame, if supported in such a way as to admit of the free access of air. As the bitumen became exhausted, the fine sand fell to the bottom. A furnace or stove might be contrived so as to burn this material. Perhaps a grate constructed on the plan adopted for burning sawdust, with an additional contrivance for

Possible substitute for coal.

removing the sand, would be found to succeed, and, if so, the banks of the Athabasca would furnish an inexhaustible supply of fuel.

Other uses. This fine asphaltic sand might also be utilized, with little or no treatment, for pavements, roofing, the manufacture of drain tiles, etc. etc., and also for insulating electric wires.

Lubricating Oil. A very superior lubricating oil may be manufactured from it. Mr. Hoffmann, of this Survey, Mr. Isaac Waterman, the well-known petroleum refiner of London, Ont., and Lieut. Cochrane, instructor in practical chemistry at the Military College, Kingston, have found it to

Percentage. contain from 12 to 15 per cent. of bitumen. Although this proportion may appear small, yet the material occurs in such enormous quantities

Methods of extraction. that a profitable means of extracting the oil and paraffin which it contains may be found. The high banks of the river and its branches offer an easy means of excavating it; and, as it burns readily, one part might be consumed to extract the oil from another, there being practically no limit to the quantity which may be obtained for the digging. Dr. Hunt suggests that the lighter and less valuable oils, obtained in the process of distilling, might be used to percolate through or lixiviate large masses of the crude material, and that in this way a large proportion of the better part of the oil which it contains might be cheaply obtained on a large scale. Mr. Hoffmann found that, in the sample he tried, 69.26 per cent. of the bitumen was removed by boiling or macerating in hot water, the extracted bitumen containing 50.1 per cent. of sand.* This might be found to be a good method of reducing the bulk of the material to be distilled for oil or for the purpose of making gas. The natural "tar," which has been already referred to, may be found to be in sufficient quantities to be available for the manufacture of oil. Mr. Waterman informed me that the

Paraffine. proportion of paraffine in the bitumen of the sample submitted to him appeared to be large, and it is possible that this substance might be profitably extracted for export from the deposits which have been described.

Transportation of the oil. The principal obstacle in the way of a speedy development of the oil-fields of the Athabasca is their distance from a sufficient market. There is, however, a near prospect of this difficulty being removed by the construction of one or another of the projected railways into the region, for which charters have been granted. A beginning might, in the meantime, be made for the supply of the Northwest Territories themselves, where the price of mineral oil is excessively high. Independent of railway construction, an outlet for the oil to foreign markets might be found by conveying it by steamers, for which there is

* See analyses and reports by Mr. Hoffmann, Geological Survey Reports for '80, '81, '82, pp. 3 to 5 H.

uninterrupted navigation, from the Athabasca River to the eastern extremity of the lake of the same name, and thence by a pipe to Churchill Harbor on Hudson's Bay.

As complete a collection as possible of the Lepidoptera of the region traversed was made, and the specimens were sent to Mr. H. H. Lyman, of Montreal, a well-known entomologist, who has kindly determined the species, and furnished us with the list which is given as an appendix to this report. A few specimens, about which Mr. Lyman had doubts, were submitted by him to the principal authorities on the Lepidoptera in the United States. Where more than one specimen of any species was taken at the same locality, the number is given after the name.

Lepidoptera.

List.

Authorities.

APPENDIX.

LIST OF LEPIDOPTERA COLLECTED IN THE NORTHWEST TERRITORIES BY DR. ROBERT BELL IN 1882.

Lac la Biche, June and July.—*Papilio turnus*, L.

Near Flat Creek, July.—*Satyrus nephele*, Kirby, 2.

Camp between Fifth Siding of the C. P. Ry. and West Creek, July 22nd.—*Hepialus quadriguttatus*, Grote.

Fort Qu'Appelle, July 24th and 25th.—*Colias christina*, Edw. *Argynnis lais*, Edw. *Phyciodes tharos*, Drury. *Cœnonympha pamphiloides*, Peak. *Satyrus nephele*, Kirby, 4. *Hypoprepia fucosa*, Hubner.

Between Fort Qu'Appelle and Touchwood Hills, July 25th and 26th.—*Argynnis lais*, Edw., Kirby, 2.

Touchwood Hills, July 26th to 31st.—*Colias christina*, Edw., 5. *Argynnis lais*, Edw., 5. *Argynnis myrina*, Cram. *Phyciodes tharos*, Drury, 6. *Vanessa antiopa*, L. *Limenitis arthemis*, Drury. *Limenitis disippus*, Godt. *Satyrus nephele*, Kirby, 4. *Lycœna sæpiolus*, Boisd, 2. *Pamphila mystic*, Edw. *Plusia simplex*, Green.

White Sand River, July 28th to 29th.—*Colias christina*, Edw. *Argynnis cybele*, F. *Argynnis lais*, Edw. *Limenitis arthemis*, Drury. *Limenitis disippus*, Godt. *Satyrus nephele*, Kirby, 2. *Lycœna sæpiolus*, Boisd.

Round Plain, July 30th.—*Argynnis lais*, Edw. *Limenitis arthemis*, Drury. *Satyrus nephele*, Kirby, 2. *Lycœna sæpiolus*, Boisd. *Hadena devastator*, Brace.

Salt Plain, August 2nd and 3rd.—*Colias christina*, Edw. *Argynnis lais*, Edw. *Phyciodes tharos*, Drury. *Cœnonympha pamphiloides*, Peak. *Satyrus nephele*, Kirby, 2. *Lycœna sæpiolus*, Boisd.

Humboldt, August 3rd and 4th.—*Colias christina*, Edw., 2. *Argynnis cybele*, F., 2. *Argynnis lais*, Edw., 2. *Phyciodes tharos*, Drury, 2. *Vanessa antiopa*, L. *Satyrus nephele*, Kirby, 2. *Lycœna sæpiolus*, Boisd. *Hadena devastator*, Brace, 2. *Crambus.*

Vermilion Lake, August 4th.—*Colias christina*. Edw. *Argynnis cybele*, F. *Argynnis lais*, Edw. *Phyciodes tharos*, Drury, 2. *Satyrus nephele*, Kirby. *Lycœna sæpiolus*, Boisd., 3. *Hypoprepia fucosa*, Hubner.

Gabriel's Crossing (South Saskatchewan River), August 5th.—*Colias christina*, Edw. *Argynnis lais*, Edw. *Phyciodes tharos*, Drury, 2. *Satyrus nephele*, Kirby, 2.

DUCK LAKE, August 6th.—*Colias christina*, Edw. *Argynnis cybele*, F. *Argynnis lais*, Edw. *Phyciodes tharos*, Drury, 2. *Satyrus nephele*, Kirby, 2. *Plusia simplex*, Guen.

CAMP NEAR FORT CARLETON, August 7th.—*Colias hagenii*, Edw. *Argynnis lais*, Edw., 2. *Phyciodes tharos*, Drury, 4. *Satyrus nephele*, Kirby, 2. *Lycæna sæpiolus*, Boisd. *Pamphile cernes*, (Bd.) Lec. *Plusia simplex*, Guen.

NEAR FORT PITT, August 15th and 18th.—*Phyciodes tharos*, Drury. *Vanessa antiopa*, L. *Petrophora truncata*, Hubner.