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

REPORT

ON THE

GEOLOGY OF THE THREE RIVERS MAP-SHEET

OR

NORTH-WESTERN SHEET

OF THE

'EASTERN TOWNSHIPS'

MAP

QUEBEC

BY

R. W. ELLS, LL.D., F.R.S.C.

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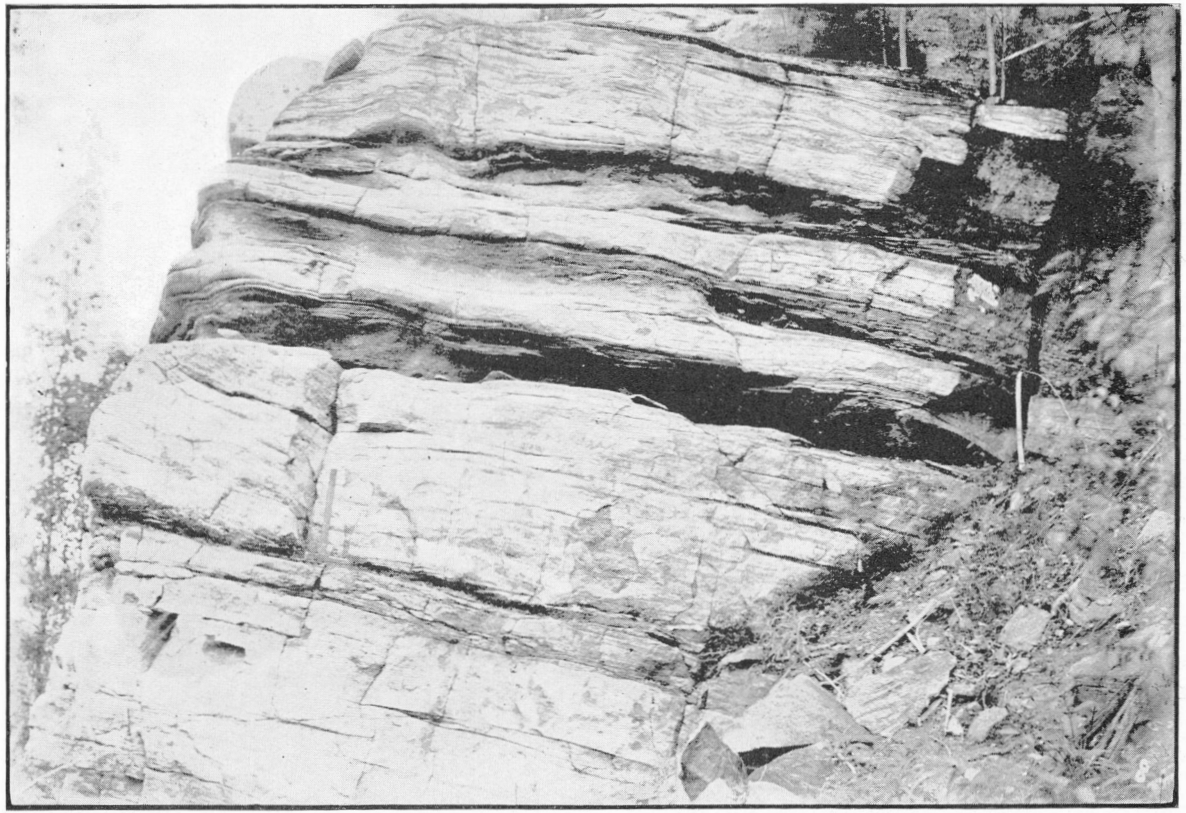

F. D. Adams, Photo, 1889.

INTERSTRATIFIED GNEISS AND LIMESTONE, RIVIÈRE DU LOUP PORTAGE, NEAR MATTAWIN RIVER, QUE.

To G. M. Dawson, C.M.G., LL.D., F.R.S.,

Director, Geological Survey of Canada.

Sir,—I beg to submit herewith a report on the Geology of the area comprised in the north-west quarter-sheet of the 'Eastern Townships' map, or Three Rivers Sheet, of the province of Quebec. The area lies chiefly to the north of the St. Lawrence River, and has been surveyed in part by several members of the staff of the Geological Survey, at various times since 1868. The final report has, however, owing to various reasons, been delayed up to the present.

I am, Sir,
Your obedient servant,

R. W. ELLS.

Ottawa, December, 1898.

NOTE.—*All the bearings mentioned in this Report are referred to the true meridian.*

REPORT

ON THE

GEOLOGY OF THE THREE RIVERS MAP-SHEET

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'EASTERN TOWNSHIPS' MAP

QUEBEC.

By R. W. ELLS.

The present report includes the result of work done by several members of the Geological Survey staff. It refers to the area comprised in the north-west quarter-sheet of the 'Eastern Townships' map, known as the 'Three Rivers Sheet.' It must be explained, however, that this sheet, completing its series of four, does not comprise any part of the 'Eastern Townships' of Quebec, properly so-called.

The projection of this series of map-sheets was laid down over thirty years ago by the late Robert Barlow, who for more than a quarter of a century was the chief draughtsman to the Geological Survey. Although first engraved in 1868, important changes of opinion as to the interpretation of several geological problems met with in the area to the east of the St. Lawrence River, interfered with its official publication as a geological map for nearly twenty years, and the first map in the series, known in the catalogue as the 'Sherbrooke Sheet,' only appeared in 1886. This was followed in 1887-88 by the 'Quebec Sheet,' which completed the eastern half of the series. In the report for 1894 the south-west or 'Montreal Sheet' appeared, and in 1895 a portion of the sheet under consideration, or 'Three Rivers Sheet,' was published in connection with a special report by

Former publications.

Dr. F. D. Adams on the anorthosite areas situated to the north-west of Montreal. In the meantime, new surveys and explorations had accumulated in such amount as to render it necessary to re-engrave more than half the area of the sheet.

Earlier explorations in the district.

Geological explorations have been carried on at different times in this district since 1852. The results of the examinations for that year appeared in the Report of the Geological Survey for 1852-53, and subsequently, in condensed form, in the Geology of Canada, 1863. These results, however, related merely to the distribution and delineation of the Palæozoic formations which lie to the north of the River St. Lawrence, and in its more immediate vicinity, since, prior to the publication of the volume referred to for 1863, but little attempt was made to mark the distribution of the several members of the crystalline rocks in this district.

Mr. James Richardson.

In connection with the earlier work in this field, may be mentioned that of Mr. James Richardson, one of the first explorers on the staff; who, in 1852, made a series of paced surveys in the district along the lower portion of the St. Maurice River, and, farther west, along L'Assomption and Lac Ouareau rivers, as also in the vicinity of Joliette (then called the village of Industry), Kildare and along the Chicot River.

Sir W. E. Logan.

In the same year, Sir W. E. Logan also made a series of paced surveys in the area along the lower part of the Batiscan River, as well as in the vicinity of the St. Maurice, near the town of Three Rivers. This work of Richardson and Logan was largely undertaken to determine the boundaries of the several formations of the sedimentary rocks from the Potsdam sandstone to the Lorraine shales. All the divisions of the Palæozoic series between these two are apparently developed in the flat country bordering on the St. Lawrence, between Montreal and Quebec, before reaching the higher ground occupied by the gneissic and granitic rocks.

Mr. James Lowe.

In 1868, exploratory work was again taken up by Mr. James Lowe, in the northern portion of the area. In that year Mr. Lowe made a traverse from the upper part of the Rouge River to the head-waters of the Mattawin. In the following year, this was supplemented by a survey of the Brassard road, which leads from the village of St. Jean de Matha, in the county of Joliette, to the village of St. Michel des Saints on the upper part of the Mattawin, and, continuing his survey, he carried an exploratory line to the head-waters of the Rivière du Post, or Clear Lake River, reaching the northern limit of the map-sheet.

Further to the north, Mr. A. Webster made a section of the rocks along what is known as the Arcand-Temple line, which leaves the St. Maurice River at a distance of about seventy miles in a direct line above the mouth of the Mattawin, and extends south-west to Lake Atikomah, a distance of thirty miles. The continuation of this line of section was made east of the St. Maurice for a distance of ten miles. Mr. A. Webster.

In 1870, Mr. James Richardson, still farther north, carried an exploratory survey from the Mistassini River to the head of the Gatineau River, and descended the latter to the mouth of the Desert, which is about ninety miles north of the city of Ottawa. In this traverse the upper portion of the St. Maurice was followed to the height-of-land at the head of the Gatineau. These two lines of exploration, though situated to the north of the present map-sheet, are of importance as affording much information relative to the geological structure of the area as the height-of-land is approached, since they enable us to carry the lines observed in the northern portion of our sheet, northward, almost to the watershed between the St. Lawrence waters and those flowing into James Bay. On this latter exploration by Richardson the rock exposures are comparatively few, as is indeed the case throughout much of this northern area, owing to the fact that most of the surface of the country in this direction is comparatively level and is covered to a great extent with sand and gravel drift. The rocks seen throughout are, for the most part, gneisses of the type usually found in the district north of the Ottawa, and the same may be said of those found on the line of section made by Mr. Webster, where the gneiss is grayish and hornblendic, or reddish, and sometimes garnetiferous, resembling the prevalent gneisses of the St. Lawrence and lower Ottawa districts. They are thus identified with those included in the Grenville series, rather than with those belonging to what has been styled the Fundamental Gneiss. Mr. James Richardson. Country about the height-of-land.

Throughout these more northerly lines of exploration a series of well-defined anticlines is seen. The strike is generally to the north or north-east and the dip changes in several places from east to west. The angles of inclination are generally low. Anticlinal structure.

In 1870, Mr. McOuat was sent to carry out a series of paced surveys in the area to the north of the St. Lawrence. He spent several months in the lower part of the Batiscan district and farther west, in the area along the Rivière du Loup (en haut). In 1871, and in the following year Mr. A. Webster made a number of paced surveys of Mr. W. McOuat.

roads in the district comprising L'Achigan, Joliette and St. Jean de Matha, and also both to the east and west of Three Rivers.

Mr. L.R. Ord. Still later, in 1879 and 1880, Mr. L. R. Ord carried on somewhat extensive explorations and made surveys with the micrometer telescope and by pacing, in the area lying north and south of the Mattawin River, and completed an instrumental survey of that stream from St. Michel des Saints to its junction with the St. Maurice. In connection with his work, surveys were also made of many of the hitherto little known lakes and streams that are tributary to the Mattawin, both from the north and south, and our knowledge of the geology of the district was greatly increased.

Mr. R. G. McConnell. In 1880, Mr. R. G. McConnell made a number of road surveys in the district between St. Jean de Matha and the lower St. Maurice in the vicinity of Shawenegan. These extended north to the Wapizagonke and Piles lakes and south to Hunterstown on the Rivière du Loup. This work led to the delineation of a large area of reddish granite which occurs to the east of St. Gabriel de Brandon. He also located several masses of anorthosite rock that are important features in the geology of this district.

Dr. F. D. Adams. In 1887 and the three following years, Dr. F. D. Adams made close investigations over a considerable area in the western portion of the map-sheet, more especially in determining and outlining the extensive masses of anorthosite rock that are found to the north-east of the town of St. Jerome. In this connection, examinations were also made along a portion of the Mattawin and of a number of lakes and streams adjacent to it. The result of this work has already appeared on the map of the south-west portion of this area.

Mr. A.P. Low In 1891, Mr. A. P. Low examined and mapped the geology of that part of the map-sheet lying to the east of the St. Maurice River, in continuation of his work in the north-west portion of the 'Quebec Sheet' which adjoins it on the east. Most of the roads in this district were surveyed by his assistants.

Mr. N. J. Giroux. In 1891 and the two following years, Mr. N. J. Giroux endeavoured to complete the surveys in the area to the west of the St. Maurice, and made surveys, chiefly with the micrometer and odometer, of most of the streams, lakes and roads between the northern limit of the sheet and the southern limit of the crystalline rocks, in so far as this had not been already done.

Dr. R. W. Ells During the season of 1898 the writer of this report traversed much of the area along the Mattawin and as far north as the head-waters of

the Vermilion and Manouan rivers, almost reaching the west end of Webster's section of 1870. His examinations extended as far east as the St. Maurice at Grandes Piles, and included a portion of the area between Joliette, St. Gabriel de Brandon and the country to the north and east of that district.

It may be said, therefore, that the greater portion of the area included in this map-sheet, has been carefully examined. Much of this work has been done in places of which no maps existed; and this feature has necessitated a large amount of topographical delineation. As a result of the compilation of the large amount of material which has thus been collected from so many sources, together with much that has been secured from the Crown Lands Department at Quebec, the accompanying map may be regarded as fairly complete in both topographical and geological details.

GENERAL CHARACTER AND TOPOGRAPHICAL FEATURES OF THE DISTRICT.

The area embraced in this map-sheet is about 6,912 square miles. Area. Of this a very large portion is unsettled and without means of communication except by canoe and portage routes. The line of the principal settlements extends north of the St. Lawrence River from twenty to thirty miles. Beyond this the only road open for vehicles to the Mattawin is that known as the Brassard road, which crosses the townships of Courcelles and Provost, and reaches the river in the township of Brassard. Here roads follow the Mattawin for about six miles Physical features. to the east and west of the village of St. Michel des Saints. Along the Brassard road are the villages of Ste. Emilie d'Energie and St. Zénon. This road is the only route by which this northern country can be reached by vehicle. Along the St. Maurice, above Grandes Piles, which is the northern terminus of a railway and important as the seat of the charcoal kilns of the Radnor Iron Company, communication is had with the upper part of the river to the settlement of La Tuque by several small steamers for a distance of about seventy-five miles. This area is almost untraversed by roads. The whole northern part of the district is therefore practically an unsettled wilderness, Game. abounding in large game, comprising bear, moose, caribou and deer. The beaver is yet plentiful along most of the rivers tributary to the Mattawin, and many of the lakes are well stocked with fish, pike being the most plentiful, though trout abounds in some of the inland lakes.

Exploration is, however, rendered comparatively easy by the number of streams and lakes which are everywhere found, though the portages are in many cases long and difficult.

St. Maurice River.

Of the many rivers that traverse this area north of the St. Lawrence River, the principal is the St. Maurice. This stream rises near the sources of the Ottawa, the Gatineau and Lièvre, and after a course of some three hundred miles empties into the St. Lawrence at the city of Three Rivers, nearly ten miles below Lake St. Peter. It has many tributaries, the chief of which on the west are the Mattawin and the Vermilion. The former of these traverses the entire north-western portion of the area under discussion, and takes its rise in lakes near the head-waters of the Rouge River. Several of its upper branches unite with the main stream not far from the village of St. Michel des Saints, whence the Mattawin becomes a large river, flowing with a generally slow current to the St. Maurice, but broken by many rapids and falls, necessitating about thirty portages. There are but few branches from the south and none of any length, as the height-of-land between this river and the St. Lawrence is rarely more than eight to ten miles distant.

Mattawin River.

Branches of the Mattawin from the north

From the north, however, in addition to the several branches that unite about fifteen miles above St. Michel village, there are several important tributaries, some of which are connected with large chains of lakes. Of these the principal are the Milieu, which enters the Mattawin about eight miles below the village of St. Michel, and the Post or Clear Lake River, which comes in two miles further north. The former of these takes its rise within a short distance of the upper waters of the Manouan, but from its very rough character along a considerable portion of its course is rarely used as a connecting route between the Mattawin and the northern waters. The Post takes its rise in Lake Clear, which is about six miles long by three miles in width, and is separated from the waters of the Vermilion by a sand and gravel ridge which has an elevation of about sixty feet, the portage between the two rivers being less than half a mile in length.

Canoe-routes.

From the west side of the Post, canoe-routes reach the Manouan waters also by means of the Hamel Brook, or by the Long Lake River, into Crooked Lake, whence Long Lake is reached by a portage 1,400 paces long. Long Lake has a length of nearly twelve miles, extending to the north-west, and from its head, Lake Traverse is reached by a portage of 750 paces. The portage from the head of Traverse Lake to Lake Sasikinegog on the Manouan waters is nearly a mile in length,

and the waters of the latter lake are at a level about eighty feet lower than those of Lake Traverse.

Lakes Sasikinegog and Traverse lie just to the north of the map-sheet, but were traversed in order to make our connections with the head of the Milieu. The first-named lake is large with a number of long arms, and the rocks around its shores belong to the upper series of gneiss and quartzite of the lower Ottawa district. The country along this route is otherwise uninteresting, the rock exposures being few, the hills densely wooded and the drift extensive.

Branches of Mattawin.

Descending the Mattawin from the mouth of the Post River, the principal streams from the north are the Cenelles, the Chienne, the Eagle and the Castor Noir. The Eagle and Chienne have large lakes near their sources, and from these routes extend across to lakes on the the Wessonneau, another branch of the St. Maurice that enters that river about thirty miles north of the Mattawin and furnishes a very good section across the upper portion of the area. All these streams and lakes have been traversed by the officers of the Geological Survey.

Rivers east of the St. Maurice.

On the east side of the St. Maurice there are also several branches, the principal of which, included in this area, is the Mekinac, which drains a chain of large lakes in the northern portion of the sheet. Farther east, the Batiscan is an important stream and flows across the eastern part of the area, entering the St. Lawrence about eighteen miles east of Three Rivers, while the River Ste. Anne which has been the scene of so many land-slides in recent years, has its mouth about four miles east of the mouth of the Batiscan. The lower portions of these rivers, for eight to twelve miles, flow through the great deposits of clay and sand that occupy the flat country north of the St. Lawrence, and afford but few rock exposures.

Rivers west of the St. Maurice.

Also north of the St. Lawrence and tributary to that river, but west of the St. Maurice, are several important streams. Among these are the Lac Ouareau, L'Assomption, Mastigouche, du Loup, Maskinongé and Yamachiche. The Shawenegan falls into the St. Maurice at the celebrated Shawenegan Falls, about eighteen miles from its mouth. All these streams have been traversed, together with the numerous chains of lakes along their courses.

Character of country west of the St. Lawrence.

While most of this area is hilly, and sometimes mountainous, a large part of it presents comparatively few rock exposures. Over much of the country north of the St. Lawrence, and in its more immediate vicinity, there is a wide-spread mantle of drift, consisting of clays,

sometimes overlain by sands and gravel, and sometimes interstratified with these. In places, as to the south and north of Joliette, these sand deposits take the form of dunes and the sand blows far and wide, so that vegetation over large areas is almost entirely destroyed. In the more northern portions of the area the sand and gravel are more generally distributed and the surface is comparatively level, showing but few rock outcrops, while the shores of the lakes and the banks of the rivers are composed of gravel and water-worn stones, forming terraces from fifty to one hundred and fifty feet in height. This generally level character of the country near the height-of-land, and for some miles on either side, has been pointed out by all the explorers in the district north of the St. Lawrence.

Terraces.

GEOLOGY.

Palæozoic formations.

As a result of the extensive drift deposits in the vicinity of the St. Lawrence, the delimitation of the several formations between that river and the edge of the crystalline rocks must always remain largely conjectural, and must depend upon the few widely scattered outcrops and upon the prolongation of the lines of strike between these, together with the estimated thickness of these formations where this can be determined. The Palæozoic formations as a rule are very nearly horizontal. They are, however, in places affected by local faults. In the area east of the St. Maurice, Mr. Low reports only four outcrops of the sedimentary formations between that river and the eastern limit of the area as shown on the map-sheet.

Area south of the St. Lawrence.

On the south side of the St. Lawrence, the area of the map-sheet is confined to the immediate vicinity of that river. This area is traversed by the lower portions of several rivers, among which are the Bécancour and the two branches of the Nicolet. On all these the rock exposures are good and the relations of the several formations can be well seen. This area is also traversed by several large faults, among which probably the most important is the great St. Lawrence and Champlain fault, which has been described in the report on the 'Montreal Sheet.'

In the subjoined table, the formations represented in the area of the Three Rivers map-sheet are arranged in descending order, separate

columns being given to the regions east and west of the St. Lawrence and Champlain fault.

List of formations.

System.	Formations.		Character of Strata, etc.	
	W. of Fault.	E. of Fault.	W. of Fault.	E. of Fault.
Silurian.	Medina.		Red shales and sandstones.	
Cambro-Silurian or Ordovician.	Lorraine.		Grayish shales and sandstones.	
	Utica.		Black bituminous shales	
	Trenton.	(Farnham)	Limestones.	Black graptolitic shales and black or dark impure limestones.
	Black River.		Limestones.	
	Chazy.		Chiefly limestone.	
	Calciferous.		Shale in lower part Magnesian limestones.	
	Potsdam.		Sandstones.	
Cambrian.		Sillery.		Red, and gray and green slates and greenish-gray sandstones.
Archæan.	Grenville.		Gneisses and limestones with granites and igneous rocks.	

Name Laurentian first used.

In the Report of the Geological Survey for 1851-52, the geological scale begins with the Metamorphic or gneissoid group. This is succeeded in ascending order, by the Potsdam sandstone. But in the report for 1852-53, this classification is changed by the use for the first time in the nomenclature of the Canadian Geological Survey, of the term Laurentian. The reason for the adoption of this term is given by Sir W. E. Logan on page 8 of that report, in which he says, 'The name which has been given in the previous reports to the rocks underlying the fossiliferous formations in this part of Canada, is the Metamorphic series, but inasmuch as this is applicable to any series of rocks in an altered condition, and might occasion confusion, it has been considered expedient to apply to them for the future, the more distinctive appellation of the Laurentian series, a name founded on that given by Mr. Garneau to the chain of hills which they compose.'

PALÆOZOIC FORMATIONS NORTH OF THE ST. LAWRENCE.

The Palæozoic formations found in the area situated to the north of the St. Lawrence, have already been briefly described in the early reports of Sir W. E. Logan, and the characters of the country, with the difficulties which exist in the attempt to decipher the structure of this district, have been pointed out. During the examinations by Mr. Giroux in 1891-2 of the area to the west of the St. Maurice River, careful attention was directed to finding outcrops of the Cambro-Silurian limestones in the district to the south of the crystalline rocks, and a number of outcrops, not noted by former observers, were located. From these places collections of fossils were made, which have been examined by Dr. H. M. Ami, by whom full lists of the species obtained have been prepared, and these accompany this report.

Fossils.

L'Assomption River.

Along L'Assomption River, near the town of Joliette, formerly known as the village of Industry, the best sections of the Cambro-Silurian strata are found. These are well exposed at intervals to a point about six miles above the town in a direct line, though the distance by the stream is much greater. South of Joliette the exposures also extend for several miles. The formations here developed, range from the Potsdam sandstone to the top of the Trenton. The town of Joliette lies just to the south of the southern limit of this map-sheet, being situated on the 'Montreal Sheet,' and a reference was made to the occurrence of Chazy and Trenton rocks near this place in the report on that area,* where the lists of fossils collected from this locality are given.

The Potsdam sandstones.

Ascending L'Assomption River the southern limit of the crystalline rocks is reached at a distance of about six and a half miles in a direct line from Joliette. The Potsdam sandstone formation appears along this part of the stream and is first seen at a place known as Bordeleau's mills, about four miles north of the town. The lowest member of the formation here, has a breadth of one mile and a half, and is a quartz conglomerate. The sandstone is usually a coarse whitish-gray rock, full of clear grains and small blebs of quartz, brownish and often rusty-weathering, and some of the beds are disturbed so that the dip could not be ascertained. The surface of the sandstone is often decomposed to a depth of four inches. Near this place a small quantity of disseminated pyrites has led to the supposition on the part of the settlers that gold exists in these rocks, and an opening has been made in consequence. The dip of the sandstone

Supposed gold mine.

*Annual Report, Geol. Surv. Can., vol. VII. (N.S.), 1894, pp. 120-121 J, and 146-147 J.

along the rapids is at one point observed to be S. 70° E. < 12°. The last mile between the upper outcrop of the sandstone and conglomerate of this formation, and the first exposure of the gneiss, shows no ledges of rock, the banks of the stream being composed of sand and clay.

Calciferous limestone.

The exposed breadth of the Potsdam sandstone on this river is less than two miles. It is succeeded by the Calciferous limestone which appears at several points for a distance of two miles and a half in a direct line below Bordeleau Rapids. These are well exposed at several rapids along this portion of the river as at the foot of the Bordeleau, where they are almost in contact with the underlying sandstone, and represent the transition beds of the formation. They also appear at the Rapides des Sœurs and contain fossils in abundance, and lower down, are seen at the Rouleau and Beaudry Rapids. The dip of the limestones is to the south at low angles, from one to three degrees. The last exposures of this formation are about one mile and a half in a direct line above the town. The rock here contains small patches and vugs of pink calcite, and is rough and brown-weathering, with a concretionary aspect on the weathered surface. Below this nearly to the dam above the town, the banks are sandy and without exposures.

Chazy limestones.

About a fourth of a mile above the dam, are outcrops of gray calcareous sandy rock with clear grains of quartz, weathering brown. These are flat and show no fossils. They may represent the lower portion of the Chazy which is well developed in the upper or northern part of the town of Joliette, but of which the lower or shaly and sandy members are absent, unless they occupy that part of the river above the dam to the last recorded exposure of the Calciferous limestone.

Black River and Trenton.

In Joliette itself both the Chazy and Trenton limestones are seen. The strata here are affected by several faults, the dip sometimes being as high as sixty degrees. A small outcrop of the Black River limestone apparently comes in between the Chazy and Trenton proper. In these rocks several important quarries are established. The rocks of the latter formation extend down stream for several miles but are covered by the overlying clay deposits before the Utica beds appear.

Fossil localities.

To the west of this river, similar rocks are seen on the lower part of the Lac Ouareau River, but the beds on this stream lie beyond the limits of this map-sheet and therefore need only be referred to. To the east, in the direction of the St. Maurice, good rock exposures appear from beneath the clay and sand at several points. On the Chaloupe River where it is crossed by the road from Joliette to Ste. Elizabeth, and for some distance on either side of the road-crossing,

broad ledges of Trenton limestone, extending down into the upper part of the Black River, are seen. These are cut through by the stream, which here flows between rocky banks. The strata are in nearly horizontal positions. The fossils obtained from this place are as follows :—

Trenton of Chaloupe River.

Chaloupe River, near bridge on road to Ste. Elizabeth, Berthier Co.

Crinoidal fragments.
Pachydictya acuta, Hall, sp.
Plectambonites sericea, Sowerby.
Rafinesquina alternata, Conrad (Emmons).
Strophomena incurvata, Shepard (=*Streptorhynchus filitextum*, Hall of authors).
Strophomena, or *Rafinesquina*, sp. indt.
Orthis (*Dalmanella*) *testudinaria*, Dalman.
Rhynchotrema inæquivalvis, Castelnau, (=*Rhynchonella increbescens*, Hall, of authors.)
Zygospira recurvirostra, Hall.
Zygospira modesta, Say., or allied species.
Conularia Trentonensis, Hall.
Protowarthia cancellata, Hall, sp. (=*Bellerophon bilobatus*. Hall, of authors.)
Trochonema umbilicatum, Hall.
Asaphus platycephalus, Stokes.
Asaphus, sp. indt.
Pterygometopus callicephalus, Hall, (sp.)
Bumastus Trentonensis, Emmons. (=*Illænus Milleri*, Billings).
Leperditia, sp. indt., a very minute form.

Near Ste. Elizabeth.

Two miles south-east of the village of Ste. Elizabeth an outcrop of the Trenton is again seen, from which were obtained :—

Crinoidal fragments.
Pachydictya acuta, Hall, sp.
Prasopora, sp.
Several branching and frondose varieties of *Monticuliporidæ* requiring microscopic sections and examinations.
Orthis (*Dalmanella*) *testudinaria*, Dalman.
Orthis, emacerata, Hall ; cf. O. *(Dalmanella) testudinaria.*
Orthis (*Dinorthis*) *pectinella*, Conrad.
Orthis tricenaria, Conrad.
Platystrophia biforata, var. *lynx*, Eichwald.
Asaphus platycephalus, Stokes.

Chicot River.

At the crossing of the Chicot River near St. Cuthbert, and eight chains below the bridge, the following were obtained :—

Crinoidal fragments,
Monticuliporidæ, several branching forms.
Solenopora compacta, Billings, sp.
Plectambonites sericea, Sowerby, sp.
Orthis (Dalmanella) testudinaria Dalman.
Orthis (Hebertella) occidentalis, Hall.
Zygospira recurvirostra, Hall.
Asaphus, sp.
Calymmene senaria, Conrad.
Pterygometopus callicephalus, Hall, sp.
Remopleurides Canadensis, Billings, or a closely related species.

From Robillard's quarry, four miles north-east of the town of Joliette on the main road between this place and Ste. Elizabeth, the following were collected : Robillard's quarry.

Crinoidal fragments.
Rafinesquina alternata, Conrad, (Emmons.)
Strophomena incurvata, Shepard (=*Streptorhynchus filitextum*, Hall.)
Plectambonites sericea, Sowerby.
Orthis (Dalmanella) testudinaria, Dalman.
Orthis (Dalmanella) testudinaria emacerata, Hall.
Orthis (Dinorthis) pectinella Emmons, var. *semiovalis*, Hall.
Asaphus, sp.
Bumastus Trentonensis, Emmons, (=*Illœnus Milleri*, Billings).

At Defond's quarry on the Chicot River, near St. Cuthbert. Defond's quarry.

Crinoidal and Cystidean fragments.
Glyptocystites Logani, Billings, showing both smooth and ornamented rhombiferous plates.
Pachydictya acuta, Hall.
Stictopora paupera, Ulrich.
Monticuliporidæ, several species.
Coscinium proavium Eichwald, as of Billings.
Arthronema?, sp.
Rafinesquina alternata, Conrad, (Emmons.)
Orthis (Dalmanella) testudinaria) Dalman.
Platystrophia biforata, Schlothem, var. *lynx*, Eichwald.
Zygospira recurvirostra, Hall.
Asaphus, sp.

A second collection from the beds on the Chicot River, near the road crossing at St. Cuthbert, gave the following additional forms :— St. Cuthbert

Streptelasma corniculum, Hall.
Pachydictya acuta, Hall.
Ptilodictya maculata, Ulrich.
Batostoma Ottawaense, Foord, or allied species.
Solenopora compacta, Billings.
Leptœna (Plectambonites) sericea, Sowerby.
Strophomena, or *Rafinesquina*, sp. indt.
Strophomena incurvata, Shepard.
Rhynchotrema inæquivalvis, Castelnau (=*Rhynchonella increbescens*, Hall, and authors generally.)
Zygospira recurvirostra, Hall.

At Fafard's quarry, near St. Cuthbert village, the following were obtained :— Fafard's quarry.

Solenopora compacta, Billings.
Rafinesquina alternata, Conrad (Emmons).
Strophomena incurvata, Shepard.
Orthis (Dalmanella) testudinaria, Dalman.
Rhynchotrema inequivalvis, Castelnau.
Zygospira recurvirostra, Hall.

McGee's quarry.

From McGee's quarry, near St. Cuthbert village :—

Pachydictya acuta, Hall.
Batostoma Ottawaense, Foord, or allied species.
Lingula quadrata, Eichwald (as of Billings).
Leptæna (*Plectambonites*) *sericea*, Sowerby.
Strophomena (*Rafinesquina*) *alternata*, Conrad, (Emmons).
Strophomena incurvata, Shepard.
Orthis (*Dalmanella*) *testudinaria*, Dalman.
Orthis (*Dinorthis*) *pectinella*, Conrad.
" " " var. *semiovalis*, Hall.
Parastrophia hemiplicata, Hall.
Calymmene, sp.
Asaphus, sp.

Of these last rocks, Dr. Ami remarks that the dark-gray semi-crystalline limestones in which the above species occur also hold masses and layers of dark-coloured chert, very similar to that found in the lower Trenton of Hull, and other places in the Ottawa Palæozoic basin.

Further east, at François Gagnon's quarry, near the village of St. Justin, in Maskinongé Co., the following Trenton species were collected :—

Gagnon's quarry, St. Justin.

Glyptocystites Logani, Billings.
Orbiculoidea lamellosa, Hall (*Discina Circe*, Billings).
Trematis? sp.
Leptæna (*Plectambonites*) *sericea*, Sowerby.
Strophomena (*Rafinesquina*) *alternata*, Conrad, (Emmons).
Orthis (*Dalmanella*) *testudinaria*, Dalman.
Zygospira recurvirostra, Hall.
Zygospira exigua, Hall.
Conularia Trentonensis, Hall.
Conularia, sp. nov.
Protowarthia cancellata, Hall (=*Bellerophon bilobatus*, Sowerby).
Hormotoma gracilis, Hall.
Ctenodonta, sp.
Endoceras proteiforme, Hall.
Trochoceras Halli, Foord, (=*Lituites undatus*, Hall).
Calymmene senaria, Conrad.
Ceraurus pleurexanthemus, Green.

Barrett's quarry.

From Barrett's quarry, three and a half miles north-west of St. Barthélmi, Berthier Co., the following were obtained, also of Trenton age :—

Climacograptus, sp.
Crinoidal fragments.
Lingula quadrata, Eichwald (as of Billings).
(?=*Lingula Cincinnatiensis*, Hall and Whitfield).
Leptæna (*Plectambonites*) *sericea*, Sowerby.
Strophomena (*Rafinesquina*) *alternata*, Conrad (Emmons).
Strophomena (*Rafinesquina*) *deltoidea*, Conrad.
Orthis (*Dalmanella*) *testudinaria*, Dalman.

Zygospira deflecta, Hall.
Conularia Trentonensis, Hall.
Cyrtoceras, sp.
Orthoceras or *Endoceras*, sp.
Beyrichia, sp.
Asaphus platycephalus, Stokes (as of Billings).
" *megistos*, Locke.
Calymmene senaria, Conrad.
Trinucleus concentricus, Eaton.

Ste Ursule

Further east, near Ste. Ursule, in Maskinongé Co., the following species, which appear to shade upward into the Utica, were obtained :—

Hyalostelia, sp.
Orthograptus quadrimucronatus, Hall.
Climacograptus, sp., cf. *C. bicornus*, Hall.
Crinoidal columns and other fragments.
Serpulites dissolutus, Billings.
Lingula Progne, Billings.
Lingula ricciniformis, Hall.
Leptobolus, sp., cf. *L. lepis*, Hall.
Trematis terminalis, Emmons.
Strophomena, (*Rafinesquina?*) sp.
Leptæna (*Plectambonites*), sp.
Orthis (*Hebertella*), sp., cf. *H. sinuata*, Hall.
Zygospira, sp.
Zygospira exigua, Hall, sp.
Ctenodonta contracta, Salter.
Conularia Trentonensis, Hall.
Cyrtolites, sp., cf. *C. Dyeri*, Hall (=*Conradella Dyeri*).
Protowarthia cancellata, Hall (=*Bellerophon bilobatus*, Sowerby.)
Primitia, sp., or allied genus of *Ostracoda*.
Calymmene senaria, Conrad.
Harpes, sp., or *Harpina*, sp.
Triarthrus sp., small form resembling *T. Fischeri*, Billings, or young individual of *T. Becki*, Green.

Yamachiche River.

From the Dalles of the Yamachiche River, two miles east of the village of St. Barnabé, in a dark-gray semi-crystalline limestone, the following were obtained :—

Pachydictya acuta, Hall.
Monticuliporidæ, several forms.
Lingula, sp. indt.
Leptæna (*Plectambonites*) *sericea*, Sowerby.
Strophomena (*Rafinesquina*) *alternata*, Conrad (Emmons).
Strophomena incurvata, Shepard.
Orthis (*Plectorthis*) *plicatella*, Conrad.
Orthis (*Dalmanella*) *testudinaria*, Dalman.
Rhynchotrema inæquivalvis, Castelnau.
Platystrophia biforata, Schlotheim, var. *lynx*, Eichwald.
Conularia Trentonensis, Hall.
Pterygometopus callicephalus, Green.
Encrinurus punctatus, or *E. multisegmentatus*, Portlock.
Asaphus, sp. indt.

The lists for the town of Joliette and for the localities in the vicinity have already appeared in the report on the 'Montreal sheet,' and need not be here repeated.

Rocks in the lower St. Maurice.

East of the Yamachiche to the St. Maurice no ledges of the Palæozoic formations appear. It is probable, however, that the different members of the system continue through beneath the clay covering with considerable regularity, since on the St. Maurice the Potsdam sandstone and the overlying Calciferous are exposed. On this river the first exposures of the Potsdam are seen about four miles below the Shawenegan Falls, or fourteen miles from the mouth of the river in a direct line. The lower beds of the formation here consist of conglomerates, as on L'Assomption River, the pebbles consisting for the most part of quartz, and the Calciferous limestones are exposed a short distance below this point. The beds are all nearly flat. Below this, to the mouth of the river the shores are composed largely of sand and clay, but Sir W. E. Logan, in 1852, recorded the presence of a somewhat broad exposure of the Utica shale at or near Pointe à la Hache, nearly opposite the old St. Maurice forges. This is about seven miles from the mouth of the river.

Outcrops east of the St. Maurice.

In the area between the St. Maurice River and the eastern limit of the map-sheet only four rock outcrops have been noted in the Palæozoic formations. Of these, two were discovered by Sir W. E. Logan, one of which is in the seigneury of Ste. Madeleine about four and a half miles east of the river and the other on the Riviere au Lard in the same seigneury. They are both in Trenton limestones. Of those noted by Mr. Low, one is on the Charest River, near its mouth, the other on the Rivière Ste. Anne, near the village of St. Casimir. Both of these also contained fossils of Trenton age.

PALÆOZOIC FORMATIONS SOUTH OF THE ST. LAWRENCE RIVER.

Area south of the St. Lawrence. Medina shales.

In the portion of the map south of the St Lawrence River, the same succession of formations does not appear. The red shales and sandstones, which have been regarded as of Medina age, are seen on the Bécancour and Nicolet rivers, and overlie the grey shales and sandstones of the Lorraine formation. The rocks of the latter formation have a breadth of about fourteen miles inland from the shore opposite the city of Three Rivers, and in their lower portion are affected by a series of faults and folds, the strata being tilted so that the dips are in places almost vertical, and these are brought directly against the red and green slates and sandstones of the Sillery formation which are

continuous from the vicinity of Point Levis, opposite the city of Quebec. The Utica and Trenton beds of the north shore are apparently cut out by the great St. Lawrence and Champlain fault, which extends from the city of Quebec to the foot of Lake Champlain. Fault.

The relations of the several formations in this direction have been briefly described, as they are seen on the Bécancour River, in the report for the year 1887. In the year 1895, however, Mr. Giroux carried on a series of surveys along the south side of the St. Lawrence from the St. Francis River to the village of Gentilly, extending south from the St. Lawrence about fifteen miles, in order to ascertain more definitely the extent of the Medina outliers and the relations of the Lorraine shales to the underlying formations.* Outcrops in the Bécancour and Nicolet rivers.

The area of the Medina outlier of red shales in the county of Nicolet, along the Nicolet and Bécancour rivers, has its apparent southern termination on the south-west branch of the former river, beyond which these peculiar rocks are not exposed in this direction. Thence it extends north-easterly, almost to the Gentilly River, a distance of twenty miles. On the Bécancour River, the breadth of the outlier is almost eight miles, while on the north-east branch of the Nicolet it is scarcely more than two miles. No fossils have been found in the strata of this formation, but as they rest upon the horizontal strata of the Lorraine near the St. Lawrence, and differ entirely from these in aspect, they have been assigned to the Silurian system as its lowest member.

Several isolated areas of these shales appear in a similar position on the Lorraine, in the flat country east of the St. Lawrence. Their outlines have been traced as closely as possible in this great drift-covered district, and they have been delineated on the 'Quebec' and 'Montreal' sheets already published. Medina outliers.

The thickness of the red shales of the Medina in this area has been proved in the borings made for natural gas several years ago. Thus, from a statement made by Mr. Obalski, mining engineer for the Province of Quebec, and reproduced by Dr. Selwyn in the Summary Report of the Geological Survey for 1887-88, it would seem that the thickness of the formation in the concession Beauséjour, which lies about three miles south-east of the village of St. Grégoire, is about 565 feet, at which depth the gray shales of the Lorraine were struck. The results of these borings is stated in the chapter on economic geology. Borings for gas.

*Summary Report Geol. Surv. Can., 1895, pp. 70-71 A.

The underlying Lorraine shales are well exposed on the south side of the St. Lawrence, along the Bécancour and Nicolet rivers. On the former stream these rocks are apparently in contact with the rocks of the Sillery formation, but on the Nicolet a belt of black slates and limestones that represent the lower Trenton of Farnham to the south, and of the city of Quebec to the north, separates the gray shales from the red beds of the Sillery. Faults of considerable extent divide the Lorraine from the Trenton as also the latter from the Sillery. The Lorraine here carries an abundance of fossils at many points.

Lorraine shales.

The underlying Sillery beds present the usual features of red, green and black slates. These have been fully described in the earlier reports on the adjacent areas and need not be further alluded to here. The area of these rocks is confined to the extreme south-east corner of the map-sheet.

Sillery formation.

THE CRYSTALLINE ROCKS NORTH OF THE ST. LAWRENCE.

The geological features of a portion of the area embraced in the accompanying map-sheet, north of the St. Lawrence, have already been given in the report by Dr. F. D. Adams,* in connection with the distribution of the anorthosites, of which there are several areas in this part of the province, some of them of large size. In the classification of the gneisses there given, all are included under the head of Laurentian, and this is divided into the Fundamental gneiss and the upper or Grenville series of gneisses and limestones with quartzites. In the early reports on this district, the anorthosites were held to constitute the upper member of the Laurentian, and they were then regarded as altered sedimentary rocks. Later investigations on these rocks, have, however, shown them to be intrusive masses in the Grenville gneisses and limestones.

Report of Dr. Adams, 1895.

The investigations of Dr. Adams, Dr. A. E. Barlow and the writer, appear now to have shown that the Grenville series, and the Hastings series, developed to the south-west of the Ottawa River, are practically identical differing only in degree of metamorphism; and, taking the Hastings series as an intermediate term, the suggestion has also been advanced that both the Grenville and Hastings series are equivalent to the Huronian so largely developed still farther to the westward. This suggestion is, however, still the subject of nvestigation, and no rocks petrographically referable to the Huronian have been found in the district covered by the present report.

Hastings and Grenville series compared.

* Annual Report, Geol. Surv. Can., vol. VIII (N.S.) 1895, Part J.

In discussing the geology of this area, it may be stated that the great mass of the rocks seen pertain to the Grenville, rather than to the so-called Fundamental gneiss. The composition of the Grenville series, with its crystalline limestones and with rusty gneiss bands, very closely resembles that met with in the lower Ottawa district, but the calcareous members are much less widely developed. There are also large areas of anorthosite, red granite, augen-gneiss and masses of green pyroxenic diabase. With the latter are found in small quantity the same association of mica and apatite which is so marked a feature in the Ottawa and Rideau lakes districts, while with the limestones, serpentinous portions occur which sometimes hold small veins of chrysotile, (asbestus) similar to that seen in the mines at Templeton and along the Gatineau. Quartzite is also an important component of this series, and large areas of this rock, similar to that found along the Ottawa, are found associated with the gneiss as far north as the northern limit of the map-sheet.

Intrusive rocks.

Quartzite.

The definition of the so-called Fundamental gneiss, is, as a matter of fact, not always possible in this district; for, if the latter appears at all, it must be along the crests of some of the numerous anticlines that occur with a general course from south to north. These anticlines are, however, generally low, the rocks over a large area being inclined at low angles. The prevailing gneiss is the grayish and hornblendic variety, generally quartzose, and with frequent bands in which garnets are abundant.

Fundamental gneiss.

The explorations of which the results are combined in this report and the map accompanying it, are those of Mr. A. P. Low, in the area east of the St. Maurice, and those of Messrs. Adams, Giroux and McConnell in the country to the west of that river. Of these the work of Dr. Adams is already largely comprised in the report and map published in 1895, which includes that part of the general map-sheet from the west border, eastward in the Palæozoic area to a point about ten miles beyond the town of Joliette, and about eight miles east of the village of St. Gabriel de Brandon, in the crystalline area. Northward, on the western border, it includes Lake Cypress on the Mattawin waters, whence it extends eastward to Lac Sac à Commis, in the township of Decalonnes. It may perhaps be better described as having its northern limit on the parallel of 46° 30′ and the eastern on the meridian of 75° 15′.

Map accompanying Dr. Adams's report.

To the north of this boundary, the country is practically a wilderness. No settlers are found, with the exception of a few scattered along the course of the Brassard road which leads from St. Jean de

Matha to St. Michel des Saints, on the Mattawin and those along the banks of that river for a distance of six miles in either direction from that village.

Character of country on upper Mattawin River.

On many of the streams and lakes tributary to the Mattawin in its upper portion, rock exposures are few. Thus along the upper branches of the river, above the junction of the Cypress, which discharges Lake Cypress and meets the main stream about two miles and a half below the outlet of that lake, the country is largely drift-covered and the shores consist of banks of sand and gravel, with beaver meadows, so that rock exposures are rarely seen. Where they do occur. however, in this direction, the rocks are grayish and reddish-gray gneiss and the strike is generally a few degrees east of north.

Supposed gold mine near St. Michel des Saints.

On the Mattawin itself, above the village of St. Michel des Saints, the surface near the river is low and sandy and the stream very crooked. Two miles and a half up, however, there is a heavy and long rapid, caused by a ridge of gneiss which here crosses the river. The gneiss is reddish and grayish, often highly quartzose, and in places the layers abound in garnets. Small veins of quartz occur, and these sometimes carry small quantities of iron-pyrites which has been regarded by the settlers as indicating gold. Bands of black hornblende-gneiss are also seen, and the whole series is intersected by dykes of reddish and sometimes white granite or pegmatite. The strike of the rocks here is north-and south and the dip west.

Rocks around Cypress Lake.

Above this, nearly to the foot of Cypress Lake, the country adjacent to the river is low and the banks are of sand and gravel. Several heavy rapids occur in this distance, and these are sometimes caused by quantities of large boulders which in places obstruct the stream. Occasional ledges of grayish and garnetiferous gneiss with a general strike to the north-east are seen, and this course is maintained to the foot of the lake, where, at the outlet, gray gneiss has a strike N. 40° E. dip S. E. Around the shores of Cypress Lake, however, the gneiss, which is the gray and garnetiferous variety, has a constant dip of S. 30° W. or almost at right angles to the ledges along the river. Along the west shore of this lake the gray gneiss is associated with reddish gneiss and black hornblende-gneiss, the whole closely resembling the series found along the shores of Trembling Lake near the Rouge River. There are, however, no traces of crystalline limestone in this place, though the bands seen along the upper part of L'Assomption River, about four miles to the south-east of this, would, if they were continuous on their strike, appear here. The rusty gneiss which

accompanies the limestone is, however, found along the eastern shores. The continuous development of these limestone bands cannot, however, be counted upon in this area. The outcrops, where seen, are always very narrow and generally impure, and they are interrupted at many points, so that outcrops when appearing along the general strike of the gneiss are often at widely separated intervals. Their continuity is also frequently broken by the presence of intrusive masses of granite that cut across the general strike of the strata.

Limestones along L'Assomption River.

To the south and west of Cypress Lake there are high ranges of hills which separate the waters of this lake from those of Lac Ouareau. These hills resemble in character and outline the Trembling Mountain range. They are probably over 2000 feet above the waters of the lake, and may, like Trembling Mountain, represent the lower gneiss.

High ridges of Cypress Lake.

On several lakes to the south of this part of the Mattawin, notably along the west boundary of the township of Provost, the limestone again appears. It is seen along the shores of Lake Proteau or St. Grégoire, near the angle of Provost and Brassard, as also on Lakes St. Servais and Obompsawin to the south-east. On all these the limestone appears as a narrow band with rusty gneiss, the associated rocks being the usual grayish and dark garnetiferous variety. The general strike of the rocks on these lakes is north-west and south-east with a dip to the south-west and the limestone is very impure, with lumps of rusty gneiss and pyroxene. The rusty gneiss and limestone are both cut by dykes of white granite, while around the shores of these lakes, hills of reddish granite rise, which, in some cases at least, is newer than the gneiss with which it is associated.

Lakes in Provost Tp.

Crystalline limestone.

On the shores of Lake Trèfle, which is one of this chain in the town ship of Provost, though no limestone was noted, there are outcrops of the rusty gneiss. This is often very quartzose and in places is associated with quartzite. Garnets are sometimesabundant.

Garnetiferous gneisses.

The bands of limestone just mentioned, should, if continuous, cross the Mattawin near the south-west line of Brassard township. The shores along this part of the river are sandy and without exposures, so that their extension could not be traced, while the country to the north of this is almost inaccessible and shows nothing of value.

Further to the east, in the townships of Courcelles, Provost and Brassard, the limestones again appear. The rocks along the Brassard road to St. Michel have usually a low dip, but sufficient to indicate the presence of a series of light undulations. Along this road, north of

Limestone of the Brassard road.

the village of Ste. Emilie d'Energie, the rusty gneiss, which usually accompanies the limestone, appears, and there are scattered blocks of the limestone itself. It is therefore quite possible that a band of this calcareous rock which is concealed at intervals by the great mantle of drift, follows closely along the course of this road with a general north-westerly bearing. Approaching the village of St. Michel, near the east end of Lake Kaiakamak, the indications of this limestone band are more apparent, and large blocks appear along the road itself, with occasional ledges. The rusty and impure gneiss appears at the forks of the road east of the Mattawin River.

St. Michel des Saints.

About the village of St. Michel, the country is generally low and sand-covered, with hills of grayish and dark gneiss rising at a short distance. At the upper falls of the river, which are about one mile north of the church, large ledges of grayish and foliated gneissoid granite cross the stream. These are succeeded by grayish and garnetiferous gneiss, and along the road down the north side of the river, about a mile below the falls, a band of grayish crystalline limestone with rusty gneiss crosses the road. The dip here is south-west and the limestone band is exposed at intervals along the road for over three-quarters of a mile. It is presumably the extension of the band which is seen at intervals along the northern part of the Brassard road.

Limestone of Milieu River.

Further north, along the course of Milieu River, a branch of the Mattawin, limestone appears at several places in the vicinity of, though not directly on, the stream. Thus near the outlet of Lake Cutaway which is on the south-west side of the Milieu and about three miles north of the township of Brassard, there is a band of this rock about thirty feet wide, containing small quantities of plumbago, while the underlying rocks are grayish rusty and garnetiferous gneiss.

On the east side of the Milieu also, about three miles north of Perrault Creek, and near the line between the counties of Berthier and Maskinongé, a band of micaceous limestone is seen. This is in places serpentinous and mottled yellowish, apparently with chondrodite. A few scales of graphite also occur. This band can be traced for about ten chains, when the exposure is covered over with drift-sands and gravels. These two outcrops of limestone on the Milieu are about in the direction of those noted along the Mattawin and on the Brassard road.

Limestone of Post River.

Still further north, the calcareous members of this formation are seen along the upper part of Post River about two miles below the

outlet of Clear Lake, a small ledge of the limestone showing in the bed of the stream for a short distance. As the shores along this part of the river are composed largely of drift, the breadth of this band cannot be ascertained.

Crooked Lake

On Crooked Lake, also, which is reached by a portage from the lower part of Post River, by way of the Hamel Creek route, several outcrops of crystalline limestone are seen. These are along the eastern side of the east arm of the lake. The rock is generally somewhat impure, and the exposures are small. The dip is to the south-east at a low angle, but the rocks in the vicinity, and for most of the distance around the shores of the lake, are a reddish granitoid gneiss, in which the foliation is very often indistinct.

Grenville series.

The presence of these bands of limestone in this area indicates the extension of the upper Grenville gneisses and quartzite to the northern limit of the sheet.

AREA NORTH OF THE MATTAWIN.

Work north of the Mattawin River.

The examinations in this area were made principally along the Milieu, the Post and the connecting waters at the head of the Manouan, the Cenelles, Eagle, Chienne and Castor Noir, all tributaries of the Mattawin, and along the Wessonneau, which empties into the St. Maurice above the mouth of that river.

Garnetiferous gneisses.

On the Post and Milieu rivers, which were traversed to their sources, and the country explored for some miles further north, the rocks, where exposed, are generally grayish and sometimes a reddish-gray gneiss. These contain garnets in many places and the characteristic rusty quartzose gneiss of the Grenville series is a common feature. Masses of granite are frequent. This is generally foliated, but sometimes occurs as a massive rock.

Lake Clear.

The Post River takes its rise in Lake Clear. This is a beautiful sheet of water about six miles long by three in breadth in its widest part. Along the shores the rock exposures are few. Where seen the gneiss is grayish and quartzose with some rusty bands, and at one place on the east shore there is a large mass of highly quartzose grayish gneiss with a few broken dark bands, the strike of which is N. 5° to 30° W. with a west dip at a low angle. At the south end of the lake opposite the outlet, there is a low cliff of reddish gneiss, with black hornblende bands, and the dip is S. 75° W. < 10° to 15°.

The portage from the north end of this lake, over a ridge of sand and gravel, reaches the Vermilion waters at the head of Lac des Pins

Rouges. This lake is narrow and extends north for about three miles, at which point Vermilion River flows out eastward to the St. Maurice. The lake is surrounded on all sides by sand, the hills are low and rock exposures are very rare. From the outlet of the Vermilion one can pass by a series of lake expansions connected by creeks to the west end of Lac des Sables, a further distance of about ten miles north. In all this stretch only two rock exposures were noted. These were at dams, and consisted of reddish-gray gneiss, the strike of which was north with a low west dip. Granite dykes intersected the gneiss The rest of the route showed no rocks other than boulders, and along the shores of Lac des Sables banks of sand and water-worn stones had an elevation of fifty to seventy feet above the surface of the lake. The surface of the country is general, low and sandy, and there are few elevations more than 100 feet above the general level. The timber is usually scrubby spruce and small red pine.

Headwaters of Vermilion River.

From Post River to the Milieu, two routes can be followed to Crooked Lake. One of these is by the Long Lake River which comes in from the west at about four miles below the outlet of Clear Lake the other by the Hamel Creek route which leaves the Post about five miles in a direct line from its junction with the Mattawin, though the distance is much more by stream owing to its many bends. There are a number of heavy portages by either route. Along the course of Long Lake River from the Post, the rocks are for the most part, where exposed, a reddish, coarse, foliated granite About midway there are large exposures of a reddish coarse augen-gneiss with a dip to the west of 85°. The rapids along this river are caused generally by great bouldery masses of the reddish foliated granite, while the banks of the stream are often occupied by drift. At the north end of Crooked Lake, there are great exposures of the coarse, reddish foliated granite, composed of red felspar, quartz and black mica, the foliation being nearly horizontal. The rocks along the west shore of the east arm of this lake are practically the same foliated granite, but along the east side, three outcrops of limestone already referred to come in. These cannot be connected and their continuity is probably affected by granitic masses. The strike of the foliation is almost always the same as the course of the lake. Boulders of reddish granite-gneiss are frequent and these with sand and gravel form the long point that divides the lake into long bays to the east and west

Canoe-routes from Post to Milieu rivers.

Reddish granites.

The shores of the west arm are mostly a coarse red foliated granite-gneiss, having a west dip at angles 10° to 15°. On the south shore of the arm, towards the north end, the dip changes to E. < 15°. Along

the portage to Long Lake, as well as along the greater portion of that lake, the rocks are very similar to those just described. They are mostly reddish, moderately coarse granite-gneiss and there is an apparent absence of the banded grayish and garnetiferous gneiss. In this respect the rocks are like those seen along the upper Ottawa at the Petewawa and opposite Pembroke on the north side of the river. But at the upper end of Long Lake after passing the narrows the rusty-weathering grayish mica-gneiss, with garnets, again appears with a dip of E. 5° to 10°. These mica-gneisses apparently continue across to the Sasikinegog Lake on the Manouan, though at the narrows of Lake Travers, which is at the head of the Long Lake River, the reddish granite-gneiss again appears in great blocks and also in ledges. Along the shores of the Sasikinegog Lake the gneiss is of the usual grayish type with black bands, and there are large areas of grayish quartzite, similar to that observed along the lower Ottawa in connection with the limestones of the Grenville series.

Long Lake.

Sasikinegog Lake.

The strike of the rocks along the shores of this lake is from north to N. 40° E. and the dip is sometimes to the east and sometimes west at low angles. The quartzite apparently overlies the grayish and hornblendic gneisses and there are also bands of the rusty gneiss. Several large areas of a dark-green, sometimes black diorite rock, with large crystals of hornblende, occur in the large south bay where the route to the Manouan takes off, which is by way of Pasquatezebe River and Lake.

Headwaters o the Manouan.

The upper part of this river is for some miles the route followed to reach the head of the Milieu River on the way to the Mattawin. The stream is exceedingly crooked, flowing through a flat country with swamps to Lac Vaseux, from the upper part of which a portage of over a mile leads to Lac à la Tête which is near the head of this stream. Along this part of the route no ledges are seen, but large boulders of red granite-gneiss show on some of the points and islands. A portage of 450 yards leads to Lake B. which is apparently the head of the Manouan waters in this direction. Large masses, probably boulders, of grayish mica-gneiss are seen at intervals around the shores. Hills of 100 to 200 feet in height rise a short distance back from the shores, but these are all densely wooded so that no rock outcrops appear.

A portage of 500 paces over a low ridge leads from the Manouan waters to the head of the east branch of the Milieu. The first lake on this stream has low and swampy shores, but there are blocks of the gray garnetiferous and often rusty gneiss. On the next or Crooked Lake the ledges appear, and there is a heavy fall at the outlet over

grayish rusty gneiss which is cut by small and hard diabase dykes. This is associated with bands of the black hornblendic and garnetiferous gneiss along with masses of gray quartzite. From this point down to the lower end of Long Lake on this stream the shores are low and gravelly. The river is very difficult to traverse owing to the dense alder growth which almost entirely blocks the channel for miles. Boulders are frequent, and just before reaching Long Lake gray mica-gneiss appears with an east dip of ten degrees. From the foot of Long Lake where the reddish coarse granite-gneiss again comes in, the river for some miles is very rough. The rapids are frequent and often very heavy, the stream being in many places almost choked with great boulders of gneiss and granite. Occasional ledges of the grayish and reddish gneiss are seen, generally with a low east dip, and sometimes masses of reddish granite occur. For the last four miles before reaching the Mattawin the river runs between gravel banks and its course is very crooked. Occasional large blocks of reddish gneiss are seen. Along the lower part of the Milieu, both to the east and west, there are several deposits of mica associated with small quantities of apatite. These occur in pyroxenic rocks that traverse the grayish garnetiferous gneiss in the vicinity of Lake Cutaway already referred to. An attempt was made some years ago to work the mica deposits in this district, but owing to the shattered condition of many of the sheets and the distance from a market, the enterprise was abandoned.

Milieu River.

Mica deposits of Lake Cutaway.

From the association of these minerals in the rocks of this area and the general similarity in the character of the gneiss here, to that seen in the Buckingham mineral belt of the Ottawa, it would appear that these rocks in the Mattawin may safely be regarded as the equivalents of the upper Grenville gneiss and limestone. In the more immediate vicinity of the Mattawin, limestone occurs not far from the upper end of the Pine Lake expansion on the south side of the river, as well as on the north side. Other localities are on lot 12, R. II and lot 20, R. C. Brassard township. In the latter place the limestone is micaceous and is associated with serpentine which contains small threads of chrysotile.

Chrysotile of L'Assomption River.

On the upper portion of L'Assomption River along L'Assomption Lake there is a well-defined belt of this rock. It also has serpentinous bands and carries veins of chrysotile, some of which are half an inch in thickness. This limestone strikes along the course of the river about north-west, and can be traced for some miles. It does not however reach Cypress Lake, being possibly cut off by granite or by a thinning of the deposit, as is often the case.

East of Post River and about fifteen miles from its junction with the Mattawin, a portage leads across to the Cenelles River, which flows south and enters the Mattawin about fifteen miles below the Post. The Cenelles is only a small stream, but has several lakes along its upper part. The country along the stream is generally rolling, with sandy plains and hills of gneiss. This rock is often garnetiferous and has bands of quartz, but no trace of limestone was noticed by Mr. Ord in the whole distance, with the exception of a piece forming part of a boulder. The strike of the gneiss is a little west of north, and the dip generally west at a low angle. North of the Rapide Lacroix which is about four miles above the mouth of the Cenelles, limestone again appears. Of this locality Mr. Giroux says, "On a lake on Lacroix Creek and about two miles north of the Mattawin, highly quartzose grayish gneiss occurs with patches of hornblende, and near the outlet of this lake, which is at an elevation of 220 feet above the river, there is an exposure of impure limestone forming a bank about twenty feet high and resting on a whitish quartz rock which dips south-east at a low angle. Rusty gneiss also occurs. The limestone is cut by small dykes of white granite. About ten chains farther north, is another small outcrop of impure limestone, separated from the last by a band of gray garnetiferous gneiss which shows an anticlinal structure, the dips being S. 25° E. and N. 50° W. $< 20°$. The second outcrop of limestone dips S. 60° W. $< 16°$ and rests on highly quartzose gneiss which can be traced for over half a mile in a northerly direction, to a small lake at the foot of which a ledge of limestone nine feet thick and two chains long, white and crystalline, dips N. 60° W. $< 10°$ and rests on a brownish, much decomposed gneiss. The limestone at all these places is very impure, containing green pyroxene in grains and lumps distributed through the mass along with scales of brown mica."

Cenelles River

Crystalline limestone.

Along that part of the Mattawin between the upper falls, one mile below St. Michel village, and the mouth of the Cenelles, there is a general resemblance in the rocks to those which have already been described. The banks of the stream are low and sandy for a large portion of this distance and the rock outcrops are few. Rusty gneiss shows in a ledge on the south bank about a fourth of a mile above the mouth of the Milieu. The dip here is south-east $< 25°$. From the Milieu to the Post the shores are low and without exposures, but a short distance above the latter stream, ledges of gray gneiss with masses of pink felspar, occur in the river. The strike of this is too indistinct for determination.

The Mattawin below St. Michel.

From Post River to the head of the Ile de France, the shores are low and sometimes marshy. Ranges of hills, composed apparently of gray and reddish-gray gneiss, rise on either side, a short distance back from the river, but these are low and the surface generally is without marked elevations for some distance. A fourth of a mile below the head of the Ile de France, a short portage crosses over ledges of generally coarse granite, cut by dykes of a dark hornblende-diorite containing grains of magnetic iron. Several small rapids occur in the north channel past this island, caused generally by boulders of gneiss, and there are occasional ledges of a dark-gray gneiss in which the strike cannot be readily seen. Some of the bands are garnetiferous and all are of the Grenville type. The dip where visible is N. E. $<10°$.

Ile de France.

From the foot of the Ile de France to the mouth of the Red Canoe River, which enters from the north, several small outcrops of the grayish garnetiferous gneiss are seen, but the shores for the greater part of the distance are low and have sandy and bushy banks. These extend to the head of Rapide Lacroix, where the grayish quartzose gneiss, with garnetiferous bands crosses the river and extends to the lake on Lacroix Creek already referred to in the remarks on the limestones.

Garnetiferous gneiss. Lacroix Rapid.

Bottle River.

Below the mouth of the Lacroix to the mouth of Bottle River, which enters from the south side, the banks are low and bushy. Occasional low ledges of the ordinary gray gneiss cross the river, the strike being at one point N. W. and the dip N. E. $<10°$. Just below Bottle River the gneiss is flaggy and the dip changes to west $<10°$. These rocks are cut by dykes of reddish granite and there is apparently a low synclinal in this part of the section.

Cenelles Rapids.

Descending the long stretch above the mouth of Cenelles River the banks are sandy and show no ledges. At Cenelles Rapids fine grained gray and black gneiss, with bands of reddish-gray, have a strike of N. 70° W. and a dip to the east, indicating an anticline in this part. Masses of red granite which is apparently a newer rock than the associated gneiss, appear above the rapid. The angle of dip of the gneiss varies from 4° to 20°. The rock is very quartzose and contains fine-grained bands which often have large crystals of felspar. At the foot of the rapids the dip is N. $<15°$ and the gneiss is affected by a couple of low undulations.

At the Empty Barrel Rapids the portage is very rough, over great masses of reddish granite. Below this, past Green Island Rapids, the Cedars and the Cypress, to Burnt Island Rapids, the expos-

ures are few. Those seen are of gneiss, grayish and reddish-gray, and often highly quartzose. At the Cypress Rapids the strike is N. W. and the dip N. E. $<10°$. Just above the Burnt Island Rapids, a cliff of sand, covering a boulder-clay, is exposed for a height of seventy-five feet above the river. Near the head of the rapids a ledge of dark or black mica-gneiss crosses the river in nearly flat layers or with a dip to the S. W. $<5°$. Below this to the Ox Bow Rapids the shores are low and sandy with large boulders. Granites and gneiss.

The Ox Bow is overcome by a portage more than a mile in length which cuts across the head of the long bend. The first half-mile is over almost bare ledges of reddish-gray granite with black mica. This is foliated, and in places the layers are distorted after the fashion of a flow structure. There is a small muddy lake midway on this portage and the second half to the river shows no rocks other than large boulders of the foliated granite. Ox Bow portage.

Below this rapid the ledges are reddish-gray mica-gneiss, the strike is nearly east-and-west, and the dip to the north at an angle of five to ten degrees. A short distance below, the foliation in a red granite gneiss dips N. 20° E $<15°$, and thence to the Grand Price Rapids the same rocks continue and the dip is N.E. 8 to 15°.

At the head of the Grand Price the rocks are reddish-gray and dark gray gneiss, the dip changing to N. 70° E. $<15°$. The portage past this rapid is 1,200 paces long over a coarse reddish gneiss with much quartz. In places the rock is almost black from the abundance of the black mica. The dip is north two to four degrees, with low undulations. The rocks for some miles along this part of the river are thus affected. They are apparently a lower portion of the gray garnetiferous series which is so wide-spread along the upper portion of the river. At the end of the Grand Price portage the dip is N. E. $<20°$. Grand Price Rapids.

At the Little Price Rapids, the rock is a coarse reddish granitoid gneiss, overlain by the reddish-gray gneiss of the usual type. At the lower end of this portage which is about half a mile in length, the gneiss strikes N. 60° E., and dips N. 30° W. $<15°$. There is a large area of gray quartz near the lower end of the portage, but at the river the rock is a garnetiferous gneiss, with dark or black micaceous bands. These rocks are sometimes greatly twisted but the general dip is to the north at a low angle. All the gneiss is very quartzose in this part of the section.

From this down to the mouth of Rivière à la Chienne, the banks are low and sandy with occasional gneiss boulders. High hills rise on either side and all are densely wooded with a small second growth. Just below

the mouth of Rivière à la Chienne, ledges of dark-gray mica-gneiss have a north-west dip at low angles. The rocks here, however, are often much twisted and the strikes vary greatly. At the upper end of the Chien Rapids the foliation in ledges of reddish-gray gneiss is very flat, and at the foot of the rapids the dip is west $<10°$. Along the portage past the Chien Rapids the reddish-gray gneiss is in low undulations, and at the lower end the dip again becomes reversed to the east. A little below this the gneiss becomes very quartzose and rusty and strikes N. 50° W., with a south-west dip $<15°$. Thence to the head of the Triplets which is a group of three small islets, there are several undulations with low angles, the dip at this last point being S. E. $<10°$. At the lower part of the Triplets, a hill of grayish gneiss rises on the north bank, from the edge of the river to a height of about 500 feet. This is about one mile above the head of the Arachie Rapids, where reddish and reddish-gray gneiss cross the stream with a strike of N. 70° W., and dip S. 20° W. $<20°$. These rocks are a good deal disturbed and are cut across by masses of red granite, the whole forming, for half a mile or more, a very rough part of the river.

Chien Rapids.

Arachie Rapids.

From the mouth of Rivière à la Chienne, the explorations of Mr. Giroux extended north to the Wessonneau waters, which are along the northern margin of the map-sheet.

At the mouth of Rivière à la Chienne and for some miles west, the country is covered with sandy drift, which forms a slightly rolling plain, extending to Lac à la Cache, or about five and a half miles north of the Mattawin. This feature is seen in ascending the stream, which runs in a flat narrow valley, bordered by small rounded hills, densely covered with small timber. Six miles up from the Mattawin are the High Falls with a pitch of ninety feet over a reddish gneiss filled with small grains of clear quartz, dipping apparently N. 70° E. $<$ 14°. The banding is very indistinct and the foliation also disappears in places when the rock becomes a true hornblende-granite.

Rivière à la Chienne route.

From Lac à la Cache the route to Lac à la Chienne is by the west branch and through a chain of small lakes. All along the route the prevailing rock is gneiss, grayish or pinkish and with black hornblende or biotite bands. The dips are generally E. $<30°$. A feature of the mountains in this area is pointed out by Mr. Giroux, who remarks that they are much more broken and less continuous than in the ranges farther to the south and south-west, and have often one perpendicular face from 150 to 300 feet in height, fronting on the lake or stream.

Lac à la Chienne is situated in a basin-shaped area, with high mountains along the east side and low hills to the west. From the head of the lake the country appears to be comparatively level but thickly wooded. The lake is celebrated for the size and excellence of the salmon trout which abound in its waters. The east shore of the lake is generally rocky, and the rounded ledges consist of coarse reddish gneiss, holding large crystals of white-weathering felspar. Similar rocks occur on the large island, and the dip here is north $<8°$ to 10°. Lac à la Chienne.

The upper portion of Rivière à la Chienne enters this lake near the north-west angle. The stream in this upper part flows through alder swamps with banks of sand and gravel for about eight miles, when a portage-route takes off to Eagle Lake, which is at the head of Eagle River. Along this portage and the intervening lake, there are ledges of pinkish-gray gneiss, dip S. 20° W. $<20°$.

Eagle Lake is very irregularly shaped with large bays. Along the north shore the reddish gneiss is cut by dykes of white-weathering pegmatite; but the dip is difficult to determine as the rocks are low-lying and the inclination of the bands low. From the foot of the lake along the upper part of Eagle River, the rocks are highly felspathic, reddish gneiss, with bands and thick beds of black hornblende-gneiss. These reddish rocks generally weather rough from the presence of the felspar and quartz, and there is often very little mica in the rock. The quartz, which is so abundant in the gneiss along the Mattawin is much less abundant in the rocks of this area. Eagle Lake.

The rocks along the lower half of the Eagle consist for the most part of reddish granitoid gneiss, with a dip near the Mattawin of S. 20° W. $<30.°$ Ascending the river from its mouth, there is a portage of about one mile and a half to the foot of the first lake, to overcome the rapids and bad water along the lower portion of the stream. This portage turns off from the river at a small creek about midway on the route past the Arachie Rapids. Eagle River.

Along the shores of the lower lake on EagleRiver, there are cliffs of granite-gneiss composed of a yellowish quartz, red felspar and black mica. The rock is in places pyritous and foliated with a dip of S. 70° E. At the head of the lower lakes another portage leads past heavy falls and rapids to the second chain, over a ridge of foliated granite, the direction of which is the same as along the lower part of the stream. Along the shores of the upper chain of lakes the strike and dip change, and the latter is here S. 55° W. $<$ 15°. At the chute at the head of this chain of lakes, ledges of grayish and hornblende-gneiss, with garnetiferous bands, strike N. 40° W. and dip to the south-west,

Granite-gneiss

and the same brownish-gray gneiss extends up the stream presumably to the head, showing in high cliffs with bold faces next the lake or river. The hills around the lakes and along the lower part of the river are high and apparently of granitic gneiss. While the gneiss along the route is generally quartzose and in some respects resembles that of the Grenville series, it apparently underlies the upper Grenville gneiss and represents one of the broad anticlinal folds seen along the middle portion of the Mattawin River.

Sleigh Lake.

Following the upper part of Rivière à la Chienne for a further distance of about six miles above the portage into Eagle Lake, a portage is made into Sleigh Lake, one of the upper lakes at the head of the Pabelangnang River, a branch of the Vermilion. The portage from the Chienne waters into this lake is over a ridge of reddish granite, containing but little mica and hornblende. Sleigh Lake is about six miles long and varies from five chains to a mile in breadth. It is very irregular, with deep bays, and is surrounded by low hills of reddish-weathering granite-gneiss. At the south end of the lake the strike is N. 40° W., the dip S. 50° W. $<$ 30°, but throughout much of the area the foliation is very indistinct, and the weathered surface is very rough. Large distinct bands of almost pure hornblende and also of red felspar are frequent in this rock, but the quartz is much less abundant than in the area further to the south. Similar rocks are seen along the shores of Lake Dorval, which is the next lake to the south-east, where the shores are strewn with boulders of granite-gneiss.

Lac à Baude.

The outlet of Lake Dorval, which empties into Lac à Baude, is about one mile and a half long, and runs through a low valley in which boulders are very numerous, and near the lower end hills of brown coarse hornblende-gneiss rise on either side.

Lac à Baude is nearly at the same elevation as Sleigh Lake. It shows but two rock exposures, of which one is near the end of the portage from the last lake, and the other near the north end of the lake where the portage leads off to Lake Wakaumekonke. Here there is a cliff about 150 feet high, the base of which consists of a very coarse granite. The rock is reddish and holds much magnetic iron in grains. This tarnishes to a purple. The reddish granite contains also the rather rare mineral allanite, over somewhat large areas, to the extent of thirty-five per cent of the mass. The allanite crystals are of unusually large size. The containing granite, which has the aspect of an eruptive mass, is overlain by bands of hornblende-gneiss which are separated by layers of reddish quartz and felspar rock. The gneiss dips here S. 70° E. $<$ 35°, indicating a break or an anticlinal at this

place, as the prevailing dips hitherto in this area have been to the south-west.

Near the western end of this cliff a dyke of pegmatite, about five feet wide, carries numerous large crystals of mica. The quartz in the vicinity is almost black and the mica is a biotite.

Lake Wakaumekonke.

The portage to Lake Wakaumekonke is about two miles long. The lake is nearly circular with a circumference of about eight miles and is surrounded by low mountains. At the northern part, a cliff of broken and jointed red gneiss rises to a height of about eighty feet, and this rock is exposed for about two miles and a half along the north and west shores. The red gneiss is here followed by a thick band of hornblende rock, showing neither bedding nor foliation, which has a breadth of about one mile and a quarter, and is followed by the same reddish gneiss with a north-and-south strike. There are quantities of black iron sand along the shores of this lake and the red rock frequently holds bunches of iron ore.

The Wessonneau River and lakes.

The portage-route from this lake to the dam between Lakes Soucy and Steamboat Rock, which are on the Wessonneau River waters, is about three miles long and crosses six small lakes. The rocks along this route are gneiss, sometimes the black hornblendic variety, and sometimes reddish or gray. At the end of this portage, at the dam at the foot of Lake Soucy, there is a cliff of reddish-weathering granite-gneiss about 150 feet high, in which foliation is seen but no banding, and the rock holds large masses and irregular veins of coarse felspar. This gneiss extends along the east shore of Lake Steamboat Rock to within half a mile of the outlet of this lake, or to what is called the South Branch of the Wessonneau. From a point near the outlet of this lake a portage was made into Lac à la Pluie, a distance of nearly four miles in a straight line. At the height-of-land about 100 chains south-west of the latter lake, there are two small lakes, the more southern of which empties into Lake Steamboat Rock while the other discharges into Lac à la Pluie. On this last lake a hill of reddish felspathic gneiss shows a dip S. 70° E. $<28°$. The surface of the country on this traverse is covered with large boulders of reddish quartzose gneiss. The gneiss at the height of land holds thick bands which are black and micaceous, and lenticular patches as well as layers of coarsely crystalline felspar with bluish quartz. Around Lac à la Pluie there are many small sand-hills from ten to twelve feet high. The portage is swampy, and the stream flows through alder swamps and is not navigable. No rocks *in situ* are seen in this part of the route. From Lac à la Pluie the outlet down to the

Gneiss and granite.

middle branch of the Wessonneau, a distance of three and a fourth miles, was followed mostly along a portage-road, as the stream is unfit for canoes. On the route outcrops of a brown quartzose gneiss, interstratified with black micaceous layers and well banded, show a dip N. 70° W. <12°, so that a low anticline apparently occurs at this place. The surface here is also covered largely with broad areas of sand with a profusion of large and small boulders of gneiss. From the forks of the branch with the Wessonneau to the St. Maurice, a distance of about twelve miles, the former is very rough and rapid. There are few rock exposures but the bed of the stream is full of boulders.

Rough part of river.

From the mouth of the Wessonneau to the Grande Anse, twelve miles lower down, the shores of the St. Maurice are largely of sand. At this latter point a portage-route of nine miles takes inland and strikes the Wessonneau River below the Wessonneau Lake. The portage shows a few outcrops of gneiss, reddish-gray, gray and black, but the dip could not be determined as the exposures are small. This portage reaches the Wessonneau River about half a mile east of a large bay, or near the intersection of a line between the seigneuries of Batiscan and Polette. Thence along the river and Lake Wessonneau to the portage near the head, but few rock exposures are seen. Brown micaceous gneiss near the foot of the lake dips S. 60° E. <15°.

Portage from St. Maurice to Wessonneau River.

From the head of this lake to Lake Steamboat Rock the rocks met with are similar to those already described on the preceding page.

At the mouth of the Wessonneau River on this lake, reddish-brown gneiss outcrops at intervals along the shore as far as the Narrows. The rock has a general easterly dip at low angles, and varies greatly in composition, holding in places layers of hornblende-gneiss and in others patches of red, coarsely crystalline orthoclase felspar and bluish quartz. Where the latter mineral occurs the gneiss is highly quartzose and holds quantities of garnets. The shores of this lake are generally low and gravelly. The islands are also low with gravelly and bouldery beaches. The surrounding mountains are thickly wooded with small timber and the elevation of the lake is about 500 feet above the Mattawin at the mouth of the Castor Noir River.

Lake Steamboat Rock.

From the south-west end of this lake a portage of about a mile leads to the lake at the head of the East Branch of the stream just mentioned. This lake is two miles long and on the east has high hills of reddish-weathering granite-gneiss. About a mile south of this lake is another and along the connecting stream the brown gneiss dips S.

Route to Castor Noir River.

to S. 40° W. < 20° to 27°. This lake is about six miles north of the forks of the Castor Noir River, and along the east side are high bold and often bare hills apparently of the same reddish-weathering granite-gneiss.

The lower portion of the Castor Noir River is very rough and flows through a narrow valley, bounded on either side by high hills of grayish-weathering reddish-gray gneiss.

Castor Noir River and lakes.

The lakes on the west branch of the Castor Noir are reached by a long portage from the Mattawin which takes off opposite the mouth of Antikiagamak River. There are several of these lakes of large size, but the rocks all along the route as well as around the shores of these lakes are similar in character to those described along the route to the Wessonneau, further north. The three principal lakes on this branch of the Castor Noir are Lakes Eveleen, Brown and Howe.

From Inman Lake, an expansion of the east branch of Gros Castor Noir River, a portage leads across to Howe Lake, which is near the head of the Ruisseau à Bastien. A ridge about 750 feet high, of brownish gneiss, lies between these two lakes and also extends along the eastern shore of the latter. From Howe Lake a route extends across to the head of Red Pine Brook. Along the Red Pine which is a very rough stream, flowing into the Mattawin a short distance below the mouth of the Eagle, the only rocks seen are the usual gneisses. These are mostly reddish-gray and hold bands of black hornblendic gneiss. The dip is obscure but at one point appears to be N. 50° W. <8°. The valley of this stream is very rough and stony and almost bare of vegetation.

Red Pine River.

The Mattawin River.

The character of the rocks along the Mattawin from Cypress Lake to the mouth of the Eagle has already been stated. From the latter point to the mouth of the Antikiagamak River the Mattawin is rough and broken by heavy rapids and falls. In the whole distance from St. Michel to the mouth of the Antikiagamak there are no less than twenty-five of these rapids and chutes, many of which can, however, be descended by light canoes at a low stage of the water.

Limestones below Eagle Rapids.

No limestones are seen along this portion of the stream till within a couple of miles of the Eagle Rapids, where numerous blocks of white and pink limestones show in the channel; but at two miles and a half below this rapid there is a band of limestone ten feet thick containing granules of green serpentine. The strike of this band is N. 50° W. and the dip is S. W. < 25°.

Along the Arachie Rapids of the Mattawin the rock is mostly granitic in character. In much of it there is a well-defined foliation,

but large portions are destitute of this feature. The general strike of the foliation is north-west and the dip is south-west. These generally weather a deep red. The lower end of the portage past this rapid is over reddish-gray and black gneiss, cut by large dykes of red coarse pegmatite. Thence to the end of the Red Pine portage, the rocks are granitic gneiss with reddish-gray bands, generally with a low dip to the south-west. At the foot of the Red Pine portage the grayish garnetiferous gneiss again appears, with a well-defined dip to the east of 10°. This rock continues along the river to the Galet Rapids where it is in broad flaggy ledges, with a dip, at the lower part, to the north-west. This rock is often a yellowish-gray mica-gneiss with quantities of garnets in some of the layers, and this feature continues down to the Bear Rapids.

Galet and Bear Rapids.

From this point a traverse was made by Mr. Giroux to the south of the river through a chain of lakes, and across to the head-waters of the Shawenegan River. This route passes through the Little and Big Bear Lakes, Lakes Prudent, Marcotte and Upper Crooked, to the head of the creek flowing into Lake Antikiagamak. The portages between these lakes are long and rough, with numerous boulders of reddish and gray gneiss. From the east end of Upper Crooked Lake, a series of portages with small lakes leads across to Lac des Iles which flows south into the Shawenegan. On all these lakes and portages the gneiss presents practically the same aspect as that seen along the route to the north of the Mattawin. The dip where noted is generally to the south-west at a low angle, but the exposures are not numerous. Along several of the lakes the gneiss forms bold cliffs, with the steep side towards the water. These are from 150 to 400 feet in height. Similar cliffs are seen along the west side of Lake Antikiagamak in its upper portion. The rock here also is a reddish-gray gneiss but the banding is not well defined. The shores of this lake are generally low and marshy and its surface is very little higher than the level of the river at the mouth of the creek which discharges it. A portage-road 3,500 paces long connects this lake with Lac des Iles on the head of the Shawenegan, and from the latter a creek connects with Lake Wapizagonke. The latter lake is about nine miles in length, but narrow. On the north side high gneiss cliffs extend for several miles along its lower or southern end, while to the west the shore rarely shows outcrops of rock. The country surrounding is densely wooded with pine. The gneiss along the lake lies in a nearly horizontal position, and the direction of the dip is obscure.

Route from the Mattawin to Shawenegan Lake.

Lake Antikiagamak.

Lake Wapizagonke.

To the west and south-west of this lake, are several large lakes, among which the principal is Lake Caribou. This and several others in

that chain discharge into the Shawenegan at the foot of Lake Wapizagonke. On another branch of this river is Shawenegan Lake and a group of smaller lakes, and around all these the same character of gneiss is seen. The prevailing dips in this area are to the south-west. Shawenegan Lake.

Further to the south, on the branches of Rivière du Loup, Lac à la Coureuse and others of this chain show similar gneiss; but on Lac à l'Eau Claire, which is several miles further south and on another branch of the du Loup, the rock is a reddish granite and syenite, which resembles that seen in the vicinity of St. Gabriel de Brandon, and that which forms the large granitic area between that place and Hunterstown. This syenite continues along the creek to the Rivière du Loup itself.

Returning to the Mattawin, the portage past the Little Bear Rapids is very rough, over a spur of a mountain, the rocks of which are reddish and gray quartzose gneiss holding garnets, the dip of which is south-west. Bands in this rock are dark-gray and gray with black mica. At the foot of the rapids the strike changes to north-east and the dip to north-west, and fifty paces lower on the river the dip becomes reversed to N. E. $< 5°$ to $10°$. A coarse reddish granite is intruded in this gneiss in broad sheets. At the Crapaud Rapids similar granites and gneiss are seen. The rock is very much disturbed. At the Little Grant Rapids the river falls about twenty feet over a grayish quartzose gneiss that lies nearly flat, and similar rocks extend down to the Grant Rapids, past which there is a portage nearly one mile in length. At the lower end of these rapids there is a bluff of reddish and gray gneiss in which the dip is N. 50° E. $<$ 50° and the gneiss is cut by masses of granite. Apparently there are several anticlines along this part of the stream, but the dips are for the most part low. Little Bear Rapids. Crapaud and Grant Rapids.

Similar gneisses extend down past the Bouleau Rapids, beyond which the shores are lower and the banks are generally sandy. The current becomes sluggish and no further obstructions occur to the mouth of the Antikiagamak River, where the Shawenegan Fishing Club has a house. Bouleau Rapids.

From the mouth of this creek to the head of the Little Cinq Rapids, where the portage leads off to the Grand Lac des Cinq and thence down to the Grandes Piles, the only rocks seen are grayish gneiss. The shores are generally low and sandy. From this point on the Mattawin to its entrance into the St. Maurice, the river is very rough and is but little travelled. There is an almost continuous succession of heavy rapids over ledges and large boulders. The gneiss is the usual grayish quartzose variety; the strike is generally nearly north-and-south. Portage from Mattawin River to Grand Lac des Cinq.

Several low undulations appear along this part of the river and near the mouth the dip is to the N. E. $<20°$.

The portage from the head of the Little Cinq Rapids to Grand Lac des Cinq is over a ridge, and is rather more than three miles in length. The only rock-exposure shows a reddish-gray gneiss, of which the dip could not be ascertained. On the above lake, near the lower end, beyond the club-house, the shore is occupied by grayish gneiss with reddish-gray bands in nearly flat layers, or with a slight dip to the north. Several low undulations show along the shores of this lake, but the angle of the dip rarely exceeds five degrees. In the east bay the gneiss is occasionally coarse and reddish, with some black bands due to the prevalence of biotite.

The Cinq Lakes.

From this lake the usual canoe-route to the Grandes Piles is south to the head of the Cinq chain, through Lakes Dauphinais and Round. From the latter a portage of five-eights of a mile leads to Lake Clear, which is at the head of the Pêche chain of lakes. Along this chain to the outlet in the St. Maurice, the rocks are all of the usual type of reddish-gray and gray gneiss, and some of the layers are filled with garnets. The dips are generally low and the bands are in shallow undulations, varying from south-west to north-east, with a general strike to the north-west.

Canoe-route to the Pêche chain of lakes.

Along the St. Maurice, which was traversed by Mr. A. P. Low in 1891 from the mouth of the Little Bostonnais to the junction with the St. Lawrence at the city of Three Rivers, the principal rocks seen are gneiss. From his notes along this part of the river it would appear that the upper Grenville gneisses are the prevailing rocks along the stream for the greater part of this distance. At the mouth of the Little Bostonnais, which is some miles north of the limit of the map-sheet, ledges of pinkish, fine-grained gneiss, with hornblende and mica layers, are well exposed, and these extend for some distance along that stream. At the chute a short distance above its junction with the St. Maurice, the rock is described as a medium-grained syenite-gneiss, highly felspathic, with green hornblende and a little quartz. The dip here is E. $<45°$.

St. Maurice River, below Little Bostonnais River.

Below this point on the St. Maurice, similar rocks appear to prevail as far as the mouth of Rat River, holding bands of crystalline limestone at the big bend, about six miles below the mouth of the Little Bostonnais. The rock exposures along this portion of the river lie at some distance back from the shores, the river itself having banks of drift-sand and gravel for the most of this distance. Sandy terraces occur along both sides, the highest of which has an elevation of about

Terraces along river.

150 feet above the stream, but the most persistent of these is about sixty feet high, with several others at intermediate elevations. From the mouth of the Rat River to the township of Polette, which is on the northern limit of the map-sheet, the principal exposures are of fine-grained grayish mica-gneiss, weathering yellow from the decomposition of iron-pyrites and with bands of black hornblende-gneiss, in places containing garnets. The prevailing dip is N. 60° E. $<35°$ to 40°.

Crystalline limestones of Polette.

In the township of Polette, on lots 24 and 25, range II, there is a large exposure of crystalline limestone, some of which is a clear white and of fine quality. The breadth of this band at one place is said by Mr. Low to be four hundred yards. The strike is about N. 60° E. and the outcrop continues for three miles in this direction. The rock is generally coarsely crystalline and in places contains light-brown mica and green pyroxene, with small quantities of graphite. The mica is sometimes in crystals of large size and the dip of the deposit is to the south-east $<8°$ to 10°. Thence to the mouth of the Mattawin, the rock exposures are usually of a fine-grained, yellowish, often rusty gneiss, with mica and hornblende, and these are cut by large dykes of coarse red pegmatite.

Limestone along the St. Maurice, below Mattawin River.

Below the Mattawin to near the mouth of the Mekinac River which is a tributary from the east, similar reddish and gray mica-gneiss and hornblende-gneiss occur. The dip is generally N. 50° to 60° E. at angles from 10° to 30°. At about two miles above the mouth of the Mekinac, similar rusty mica- and hornblende-gneiss holds, in the space of fifty feet, four thin bands of limestone, white and crystalline. These dip N. 65° E. $<30°$ to 50°. These bands vary in thickness from four feet to six inches and appear to have eaten into the containing gneiss, as they penetrate the bedding and hold fragments of the surrounding rock. The dark gneiss is garnetiferous. The two middle calcareous bands coalesce, and at one point form a band fourteen feet thick. Below this point to the Point aux Dores, four other bands of limestone are seen, the associated gneiss being fine-grained and rusty. Some of this gneiss holds quite large masses of magnetite which is in fact a considerable ingredient in nearly all the gneisses in this area.

Mekinac River to Grandes Piles.

Below the Mekinac the river widens. The shore becomes sandy and the stream is bordered by terraces, the highest of which is about 150 feet, but the fine-grained reddish and gray gneiss continues in hill ranges down to the village of Grandes Piles.

At this place, on the east bank, the gneiss sometimes has a greenish tint from the presence of pyroxene, and contains veins of pegmatite and magnetite. The strike here is north and the dip east $<30°$ to 50°.

Similar rocks continue down stream to Petites Piles. The strike changes to N. 30° E. but the dip is still east 20° to 30°. At the latter place there are two bands of limestone from six to thirty-six inches in thickness separated by a six-inch band of pyroxene. The calcareous bands are impure, holding dark mica and pyroxene with hornblende. Overlying these are about 200 feet of pyroxene-hornblende-gneiss with veins of pegmatite, which also hold masses of pyroxene, and these are followed by the ordinary gray gneiss of the district.

Pyroxene rocks.

Along this part of the river, for a distance of about one mile, the outcrops of limestone in thin bands are quite common. They are all associated with pyroxenic rock and are not continuous. The bands vary rapidly in thickness, and are sometimes entirely interrupted, reappearing some feet further along the line of the strike. They frequently contain masses of the country rock, generally of pyroxene, and are more of the nature of segregations than of ordinary beds. In this way they more nearly resemble the masses of calcite which are found in the pyroxenes of the apatite district along the Ottawa, in which the crystals of mica and apatite occur. The colour of the limestone also resembles that found in the pyroxene mineral belt, varying from pink to white.

Limestone with pyroxene

From the Petites Piles to the Shawenegan Falls, the rocks are very similar in character to the gneisses already described. They are mostly grayish and reddish, and Mr. Low remarks that the gray gneiss generally contains, along with the mica, more or less black hornblende, while with the red there is a greenish variety, often decomposing into a mineral closely resembling chlorite. Garnets are a common constituent, and there is often much magnetite in small grains.

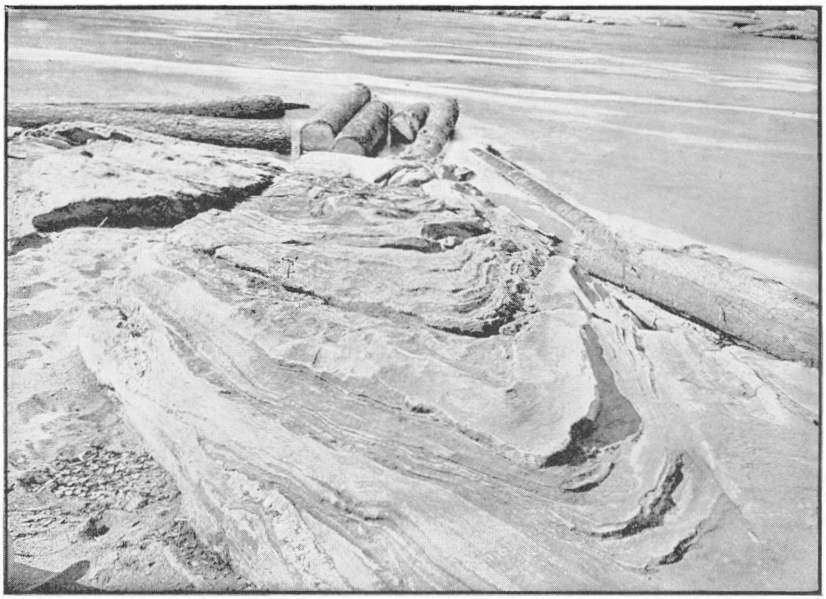
Petites Piles to Shawenegan Falls.

The Shawenegan Falls have a descent of 160 feet. The rock here differs from that on the upper stretch of the river and is rather an augen-gneiss, showing distinct banding, mostly gray and moderately fine-grained. The felspar crystals are of good size and well drawn out. Reddish bands also occur and garnets are an accessory mineral. Some bands are highly hornblendic and have large disseminated crystals of that mineral. The strike at this place is N. 20° E., and the dip east. At the foot of the large basin below the falls the strike changes to N. E., and the dip to N. W. $< 60°$, and the same character of rock is thence maintained along the lower part of the river to the overlap of the Potsdam sandstone already referred to, nearly three miles below.

Shawenegan Falls.

The upper bands of the gneiss underlying the Potsdam are uneven as if eroded before the deposition of that formation. The surface is

Contact with the Potsdam sandstone.



FOLDED BEDS OF GNEISS, BATISCAN RIVER, QUE.

A. P. Low, Photo., 1891.

FLAT-BEDDED GNEISS, BATISCAN RIVER, QUE.

decomposed to a depth of five feet and the rock here is of the schistose variety holding garnets.

THE AREA EAST OF THE ST. MAURICE.

Area east of the St. Maurice.

The area east of the St. Maurice was also traversed by Mr. Low in 1891, in continuation of his work on the north-east or "Quebec sheet." The northern portion is entirely unsettled, but is intersected by several streams, of which the principal is the Batiscan. Lakes, often of good size, are numerous, but the connecting portages are for the most part long and rough. The surface is hilly and thickly wooded and exploration is therefore rendered difficult.

The Batiscan River.

Throughout all the area to the east of the St. Maurice there is a very great similarity in the character of the rocks where exposed, not only to those in the district itself, but to those already described for the country west of the St. Maurice, and they all apparently belong to the Grenville series of gneiss and limestone. The latter rock is rarely seen, but there are a few outcrops along the shores of several lakes west of the Batiscan River.

This stream traverses the eastern portion of the map-sheet, entering it about ten miles west of the north-east angle and emptying into the St. Lawrence about eighteen miles east of the city of Three Rivers. It affords a good section from the crossing of the Lake St. John railway, diagonally across the strike of the rocks nearly to the village of Ste. Geneviève, where the country becomes low and the rocks are concealed by the great deposits of clay and sand that occupy the area to the north of the St. Lawrence.

Garnetiferous and gray gneiss.

On this river, from the crossing of the railway from Quebec to Lake St. John to the point where it meets the railway to St. Tite Junction, the prevailing rock is gneiss. This is usually the fine-grained banded mica and hornblende variety, and some of the layers are filled with garnets. The general strike is north and the dip is E. $<50°$. Near the railway bridge the rock is more massive for some distance, but the coarse- and fine-grained mica-garnet-gneiss again comes in and continues to the village of Nôtre Dame. At this place the railway leaves the river and continues more to the west while the stream turns to the south. Along the stream below this point, through the seigneuries of Grondines and Ste. Anne, the gray gneiss is associated with bands of quartzite and mica-schist.

The river from the Laurentides station on the Lake St. John line to Nôtre Dame, is generally rough and descends rapidly. There are but

Rough character of river.

few falls but a succession of heavy rapids. The valley is narrow and the hills rise on either side to elevations of 500 to 900 feet above the stream. Much gray and dark hornblende-gneiss occurs along this portion, with large blocks of the same. Some of the bands are almost entirely composed of black hornblende, but others contain felspar and mica, so that the gneiss as a whole has a well banded aspect. Approaching the railway bridge above Nôtre Dame, the rock becomes coarser and approaches a syenite in character, with associated areas of garnetiferous mica- and hornblende-schist. The more massive portions of this rock have been extensively used in constructing the piers of the railway bridge at this place and afford excellent material for building purposes.

Building stone

Gneiss of lower part of Batiscan River.

From the railway to the mouth of the Tawachiche River, the stream affords a fairly good section across the strike of the gneiss. In this distance the Batiscan is generally rough and broken by several falls. The rocks along this stretch are all similar in character, being for the most part a dark-gray schistose mica-gneiss, often containing hornblende bands and nearly always weathering rusty from the decomposition of iron-pyrites which is disseminated in small quantities throughout the strata. The strike is generally north-and-south with a dip to the east of twenty to forty-five degrees, but there are local flexings in which the strike sometimes changes to N. 50° E. The gneiss is frequently cut by pegmatite dykes, which often hold small crystals of light-coloured mica.

Terraces along stream.

Through the seigneury of Montauban the elevation of the surrounding hills gradually decreases until they are rarely more than 400 feet above the stream. The land is cultivated for several miles below the railway bridge, and terraces continue down to the boundary of West Grondines, beyond which point they are concealed by forest growth

Below the mouth of the Tawachiche River to the southern limit of the crystalline rocks, near the village of Ste. Geneviève, the river follows a nearly straight course and more closely conforms to the strike. At the mouth of the Pierre Paul River, the gray schistose gneiss often contains considerable beds of gray quartzite. The dip still continues to the east at angles of ten to forty degrees, and there are large and thick masses of pegmatite.

Garnetiferous gneiss.

Below this, to Price's mill, while the rocks are of the same general character, there is also an admixture of garnetiferous-gneiss, and some of the mica bands are replaced by black hornblende, but these are comparatively few and thin. The gneiss is unusually quartzose and the schistose structure is common. This quartzose

aspect of the gneiss is more marked as the eastern or southern margin of the area is reached. As the strike is very nearly along the course of the stream, no very great thickness of strata is exposed. The dip is nearly uniformly to the east, and the rocks very greatly resemble the bedded sediments of more recent formations, presenting much of the general aspect of bedded sediments in a highly metamorphic condition.

Bedded aspect of the gneiss.

Well-defined terraces are to be seen on both sides of this river for long distances. Three and sometimes four are common, the highest of which is at least 100 feet above the stream, while the others are at different elevations below that level.

Terraces.

The railway line from River Pierre Paul to St. Tite Junction affords a fairly good section for some miles west of the junction with the main line from Quebec to Lake St. John. Cuttings are frequent, but the rock outcrops are all very similar in character. They consist for the most part of gneiss, which is generally fine-grained and micaceous with occasional coarser bands.

Railway from River Pierre Paul to St. Tite Junction.

The gneiss is sometimes dark and hornblendic and masses of generally coarse pegmatite, which sometimes contain crystals of mica, are frequent. Very little quartzite was noted on this line of section. The strike varies from north to N.50° E. and the dip where recorded is generally to the east. Owing, however, to a lack of continuity in the outcrops there may be dips also to the west which are not apparent, as it is scarcely probable that the whole of the series, extending in section from east to west for nearly twenty-five miles, with great similarity in character throughout, is a uniformly descending one, since in that case the thickness of the upper gneiss series would be enormous.

Gneiss probably in folds.

Along the main line of railway to Lake St. John, which cuts across the north-west angle of the map-sheet, similar gneiss is exposed as far as the crossing of the Batiscan River. The cuttings are, for the most part, in a grayish-mica and sometimes hornblende-gneiss. Occasional bands of pinkish colour are also seen. The railway keeps nearly along the strike for the greater part of the distance and the dip here appears to be uniformly to the east.

Lake St. John Railway.

In the area to the north, between the Batiscan and the St. Maurice, several chains of lakes are found. Some of these lakes are of large size, and though the portages connecting them are somewhat difficult, canoe-routes exist between the two rivers and thus a fairly good opportunity is afforded to study the structure of the rocks throughout this district.

Lakes between upper Batiscan and St. Maurice.

Among the principal lakes here that have been examined, are Island, Roberge and Masketsy, which are on the head of the Tawachiche River, Big Long and Mekinac lakes, which empty through the Mekinac River into the St. Maurice, some miles north of the Grandes Piles, and Lakes St. Michel, Trout, Sleigh, Castor and Batiscan, the two latter just beyond the limit of the map, which flow into Lake Mekinac. Of these, Big Long and Mekinac lakes are the largest, and they generally lie along the strike of the gneiss, which is a few degrees west of north.

Big Long Lake.

On Big Long Lake the gneiss is usually a moderately fine-grained, banded gray and red variety, containing mica and hornblende. In places there are masses of reddish augen-gneiss, in which the augens are generally of pink felspar, and the rock also contains masses of this mineral. All these rocks are a good deal contorted and the various bands are often lenticular. Cliffs rise from the shores of the lakes to elevations of 400 to 500 feet above the surface. The recorded dip is generally N. 70° E. $<10°$ to 50°.

Lake Mekinac crystalline limestone.

Anticline.

The waters of Big Long Lake are yellowish in colour but very clear. On the east side the rocks rise almost perpendicularly from the water, while on the west the hills slope towards the shore in the direction of the dip. On Lake Mekinac the same succession of fine-grained red and gray well banded hornblendic and mica-gneisses are seen. Near the south end of the lake, cliffs similar to those of Big Long Lake appear, rising to a height of 400 feet, and about three miles from the lower end there is a sharp overturn in the gneiss, the dip changing from east to west and the angle increasing from 40 to 90 degrees. A short distance north of this, several thin bands of crystalline limestone occur, associated with green pyroxene. The width of the thickest limestone, which is pink in colour, is only eighteen inches. About midway on the east side of the lake near a small, deep bay, another sharp fold appears, with a band of limestone the exposed thicknss of which, in one place, is six feet. This band is white and holds small pieces of green pyroxene. Beyond this, northward, the rocks are much contorted, the dips changing rapidly, but the inclination soon becomes easterly, and this direction is maintained to the north end of the lake, with, however, a sharp anticline near the mouth of Brochet River, which enters the lake about two miles from the north end.

Pyroxene rocks.

It is possible that the limestones here noted are portions of the pyroxene mass, rather than sedimentary beds in the gneiss, and that they are similar in character to those seen along the St. Maurice below Grandes Piles.

On the River Brochet, just mentioned, but few rock outcrops are seen. The stream flows through a low and swampy country to the forks with the Rivière à l'Eau Morte on which, at the falls, the same character of hornblende-mica gneiss appears with a south-east dip at an angle of forty-five degrees.

General character of the gneiss.

On the whole it may be said of the rocks on these lakes and of the area adjacent, that they consist almost entirely of reddish hornblende-mica-gneiss, generally moderately fine-grained and interbanded with dark- and light-gray gneiss which is more basic. Some of the bands are coarse, and garnets are sparingly disseminated through many of the bands.

Route between Lake Mekinac and the St. Maurice.

A portage of four miles leads across from a bay on the west side of Lake Mekinac to Trout Lake. Similar yellowish-weathering grayish hornblende gneiss appears about midway on the route with an east dip 10° to 40°, and the same rock, with some coarser red bands, in which garnets are common, is seen along the shores of Lake St. Michel. The rock in this direction is generally darker in shade and resembles that seen on the St. Maurice, containing iron and dark-green felspar. The country about Trout Lake is low and swampy, with rolling hills from fifty to a hundred feet above the surface of the lake, which has an elevation of about 300 feet above Lake Mekinac.

Returning to this lake, the west shore shows but few rock exposures as compared with the east side. Those seen are usually grayish and reddish mica-gneiss dipping E. $<30°$ to 60°. The descent to the St. Maurice by the river shows but few ledges, and those seen are of schistose hornblende and mica-gneiss, with occasional coarser bands. This river is a succession of small rapids, with a swift current as far as the mouth of the Rivière la Truite, and the banks generally are low and composed of stratified clay, overlain by coarse sand and gravel. Below the mouth of the branch from Trout Lake, to the junction with the St. Maurice, rock exposures are wanting.

Lake Masketsy.

Lake Masketsy is reached by a portage from the upper end of Big Long Lake. The rocks on this lake are very similar to those already described on Lake Mekinac, being mostly moderately fine-grained mica- and hornblende-gneiss, with dykes of coarse pegmatite. Some of the gray bands are rusty, but no limestone appears. A portage leads across from this lake to Lake Roberge, over a hill about 300 feet high, and the same kind of rocks are also there exposed, the dip being N. 70° E. $<$ 15°.

Lake Roberge and Island Lake.

From the north end of this lake, a portage-route, crossing several small lakes, extends to Island Lake, which is near the northern limit

of the map-sheet. On the first of these lakes the rock is a yellowish-weathering mica-gneiss, with a dip to the east of fifty degrees, and on the portage to the next small lake a white, highly felspathic gneiss occurs, composed mostly of orthoclase and quartz, with a little mica. Much of the country along this route is low and swampy, and for three miles before reaching Island Lake is without rock exposures. The gneiss on this lake is the usual hornblende-mica variety, but there are many intrusions of pegmatite and occasional bands of quartzite occur. The dips, where seen, are all to the east, at angles of thirty to fifty degrees. From the foot of this lake a creek flows into the north end of Lake Mekinac. The rocks along this route, which is very bad, are all of the same character as already described. In fact, there is a very great similarity in character in all the rocks throughout this area.

Sleigh Lake.

From the west side of Lake Mekinac a portage of three miles leads across to Sleigh Lake, on the way out to the St. Maurice. This portage passes over a ridge about 200 feet high, but falls again before reaching Sleigh Lake, which is about forty feet higher than Lake Mekinac. Exposures on this lake are few and consist of fine-grained reddish and yellowish gneiss with much quartz, and with grains of ilmenite. A portage one mile and a half in length, through swamps, leads thence to Castor Lake, where similar rocks are found, with pegmatite, and in places much contorted, and thence a half mile portage extends to Lake Batiscan, from which a creek flows into the St. Maurice. The rocks along this part of the section are all of the same general character.

Lake Batiscan

Gneiss of the eastern part of the area.

A traverse was also made from the line of the Lake St. John railway by the Black River in the eastern section of the map which included Lakes Montaubin and Long. In this section the only rocks seen were the usual varieties of light- and dark-gray mica-gneiss with occasional masses of pegmatite. The strike is uniformly north to north-east and the dip east $<20°$ to 50.°

AREA SOUTH OF THE MATTAWIN.

Area south of the Mattawin.

This area has been very thoroughly traversed by Messrs. Ord, Adams and Giroux and in the eastern area, nearer the St. Maurice, by Mr. McConnell. Surveys of all the principal lakes and streams were made, mostly by micrometer, and most of the roads in the district have been also measured, so that the information in this area is quite complete, with the exception of certain practically inaccessible portions that are densely wooded and where rock exposures are concealed.

The principal rivers traversing this area are L'Assomption and the du Loup. These, in their upper part, are associated with extensive chains of lakes which are situated not far from the Mattawin, the height-of-land in this direction being only a few miles south of that stream. Traverses were also made of the smaller streams and lake connections between these waters and the Mattawin as well as of much of the flat country to the north of the St. Lawrence River. Principa rivers.

Of these the first line of exploration was along L'Assomption River from the town of Joliette north to the junction of Black River, which is one of the principal tributaries from the north-east. Then along this stream and its lakes to Lake Maskinongé which was reached by the Mattambine River. This lake is near the village of St. Gabriel de Brandon, and from this, north, a traverse was made by way of the Mastigouche and connecting lakes to the Rivière du Loup which was followed down to its junction with the St. Lawrence. L'Assomption River.

The lower portion of L'Assomption River, or that part between the town of Joliette and the first outcrops of the crystalline rocks, is very crooked. The stream winds between banks of clay, sand and gravel, with occasional outcrops of the Palæozoic formations which have already been referred to in previous pages. The first appearance of the gneiss is at a point known as Nadeaus Rapids, about twenty miles from Joliette by the stream. At the foot of this rapid are ledges of gray hornblende-gneiss, associated with layers which are highly quartzose and having a dip of S. 40° E. $<14°$. Thence up stream, to the mouth of Black River, rock exposures are numerous, though for considerable stretches along the river the banks are composed of sand, clay and gravel. Rocks along L'Assomption River.

The prevailing rock of the district is a gneiss. This varies from a grayish quartzose, sometimes rusty, rock to a dark hornblendic variety, and in the upper half of the distance the bands are frequently highly garnetiferous. While the banding is generally well defined, there are, along certain portions of this distance, outcrops which are granitic in character and where only an indistinct foliation can be perceived. Rapids and falls caused by harder masses are frequent. In places the gneiss, which has a regular dip for the greater part of the course, is broken through by masses of pegmatite and sometimes of diorite, and the rock in these cases is usually much shattered and disturbed. Black River was followed upward through Black Lake to near the post between lots 20 and 21, range XI and XII, Brandon, whence a portage was made to Lake Mattambine, which discharges by the Mattambine River into Lake Maskinongé. Garnetiferous gneiss.

Black River.

The rocks along Black River are all gneissic. They are often highly quartzose with hornblende and mica and have interstratified bands of reddish-gray colour. In places the rock is highly micaceous and sometimes very rusty, resembling the bands in association with the Grenville series, though no calcareous bands were observed along the stream. The strike changes to N. 20° W., and the dip is to the east at a low angle. Near Black Lake the gneiss is a gray-weathering brownish-gray rock with quartz layers. The banding is well defined and the crumpling in some parts is very marked though the dip continues to the north-east. The upper portion of this stream flows through a low and swampy area, and rock exposures are rarely seen. The only rocks exposed around Lake Mattambine are quartzites and grayish, sometimes rusty gneiss. Along the Mattambine River to Lake Maskinongé the only exposure is a dark hornblende-gneiss, about midway, but the bed of the stream is almost choked in places by boulders of grayish gneiss and anorthosite.

Lake Mattambine and river.

Lake. Maskinongé

Lake Maskinongé receives the waters of the Mastigouche River and the chain of lakes at its head. The stream enters the north end of the lake, while the discharge is by the Maskinongé River, which flows into the St. Lawrence near the upper end of Lake St. Peter.

The shores of this lake are for the most part formed of sand and boulders. Ledges are seen on the west and south between the mouth of the Mattambine and the village of St. Gabriel de Brandon, where bedded brownish-gray and gray quartzose mica-gneiss dips N. E. $<5°$. About one mile north of the village a hill of reddish-gray and gray imperfectly foliated granite-gneiss, with masses of hornblende-gneiss inclosed, rises from the water to a height of about 150 feet.

Granite near St. Gabriel de Brandon.

On the shore east of St. Gabriel, a reddish-gray granite appears being the western edge of a great mass of this rock, which has a large development in the county of Maskinongé, between St. Gabriel and Hunterstown. In places this rock is coarse and granitic, without trace of bedding or foliation; but along the margin of the outcrop, at a number of places, a well-defined foliation is visible and garnets are disseminated. Magnetite in small quantities is present and patches of bluish-white quartz occur in the granite mass. This granite will be referred to on a subsequent page.

Mastigouche River.

From the upper end of Lake Maskinongé, the Mastigouche was surveyed for fourteen miles to the portage to Chute Lake. On this part of the stream the ledges are few and are all of greenish-gray gneiss with reddish bands, the dip where observed being E. $<20°$. The river is

obstructed by heavy falls and rapids so that the traverse is difficult forseveral miles below the lake.

The only rocks around Chute Lake are the usual brownish-gray and gray gneiss, in places filled with garnets and with the usual east dip at a low angle. From this lake the Mastigouche was ascended for a further distance of twenty miles north, when a portage was made to Lac Sans Bout on the Rivière du Loup. A route from this lake leads to the Mattawin and reaches that stream a few miles north of the village of St. Michel, by way of Lakes Ignace and Barré. On this route several other lakes are traversed, and on the whole distance from Lac Sans Bout to the Mattawin, eighteen lakes and seventeen portages were surveyed. The principal of these are Lakes Clear, Lézards, Etroit, Bottle, Ignace and Barré, the latter discharging into the Mattawin.

Routes from Lac Sans Bout to the Mattawin.

On all these lakes the rocks differ very little in character. They consist of the same reddish, brownish and gray gneiss, in places holding quartz and garnets like the rocks described in the area to the north of the Mattawin. The dips for the most of the distance are to the south-west and the angles are low. In places the gneiss is much disturbed, probably through the action of granite masses. The only calcareous rock seen along this route was on a small lake a short distance to the north of Lac Sans Bout, where there is a conglomeratic appearance in certain bands of quartzose rocks, in which the paste is calcareous with lumps of dark and gray gneiss, but no well-defined limestone bands were seen.

Garnetiferous gneiss.

On the south side of Bottle Lake, near the inlet, a cliff of gneiss rises to a height of 300 feet above the water. The rock is a gray colour with the banding well-defined, often quartzose and sometimes hornblendic. The quartzose bands are filled with garnets and some of the bands contain felspar, quartz and pink calcite, the latter holding much iron in small grains. Small grains of iron-pyrites occur, and the face of the cliff is stained in places with iron rust resulting from the decomposition of this mineral. On Lac aux Lézards a well-defined anticline is seen in the gneiss. The angle of dip is low, rarely exceeding twenty degrees. From Lac Ecartant to Lac Sans Bout the dip is for the most part to the south-west, showing the presence of the same structure along this part of the route. The same series of dips is seen along Lac Sans Bout, though the ledges along the river are few, as the banks of the stream are generally low.

Bottle Lake.

Anticline.

From Lac Sans Bout a chain of smaller lakes including Lakes Violon, Bleu, and Ecorces, Culbute and Welly, leads to Lac Sac-à-

Lac Sans Bout to Lac Sac-à-Commis.

Commis, which is one of the largest in the area. The rocks along this route are reddish and brown gneiss, often garnetiferous, with occasional small masses of syenite near the last-named lake. The dips are generally to the south-east at angles of twenty-five degrees.

Lac Sac-à-Commis.

On Lac Sac-à-Commis, near the north end, the syenites again appear, but the ledges along the shores are generally of reddish and gray gneiss of the usual type. At the south-west end of this lake large exposures of reddish granite-gneiss are seen, and at the end of the long point running into the lake from the north end, dark-gray and rusty gneiss is interstratified with the red, and dips east at a low angle. Similar gneiss occurs on the large island near the middle of the lake. On the east side of the lake the gneiss is schistose and well-foliated.

Rivière du Loup.

From the east side of Lac Sans Bout a branch of the Rivière du Loup flows northward to Lac au Sorcier and thence to the main branch of that stream, and a second route in which, however, the portages are long, extends across from the north end of Lac Sac-à-Commis by way of Lake Carufel, which reaches the same branch of the Rivière du Loup about ten miles farther south. On both these routes, which cross the strike of the gneiss diagonally, the only exposures are of the reddish-gray and gray garnetiferous gneiss. The dips are all to the south-east at an inclination of twenty to thirty-five degrees. The gneiss along the Lake Carufel portage is very quartzose with a small quantity of disseminated graphite. The garnets are very abundant in certain bands everywhere along this route.

Portage-route from Mattawin to Rivière du Loup.

From the point where the portage-route from Lac Sans Bout reaches the Rivière du Loup, a route extends across to the Mattawin by way of the upper du Loup and the Michelin Brook. On this route are a number of lakes, the principal being Lafond, de la Ferme, Sand, Bay and Long Lakes. The Michelin Brook is about four miles long and has a lake at its source. On all these lakes the reddish-gray and gray gneisses are the prevailing rock. In places these are garnetiferous, and on the southern half of this part of the section the dips are to the east or south-east, but on the northern portion the dip changes to N. 25° E. and N. 25° W. The angles of dip are low rarely more than ten to fifteen degrees.

Rivière du Loup to Hunterstown.

Along the lower part of the Rivière du Loup section, for some miles, from the end of the creek flowing from Lac au Sorcier there is very little difference in the aspect of the gneiss, wherever it is seen, to within six miles of the village of St. Alexis. Along this lower portion of the river the rocks are more granitic, but with these also there are certain areas which show well-defined foliation and in places banding. From

the village of St. Alexis down to the big bend where the river turns east in the direction of Hunterstown, the rock is distinctly granitic in character, forming the eastern limit of the large red granite and syenite mass which appears to the east of the village of St. Gabriel de Brandon. On the north-east stretch of five miles to Hunterstown, the rocks again are grayish often quartzose gneiss, with rusty bands in the vicinity of that village, and here the gneiss is associated with several thin bands of crystalline limestone. Below Hunterstown the rocks are generally grayish garnetiferous gneisses of the usual type, and at about four miles south of that place these are covered over by the sands and gravels of the St. Lawrence valley.

The geological features of a large portion of the counties of Berthier, Joliette and Montcalm, included in the south-west part of this map-sheet have already appeared on the map accompanying the report by Dr. Adams, previously referred to. This area is fairly well opened up by roads, so that the study of the geology is much less difficult than that of the great wilderness country to the north and east which has just been described. In addition to the large areas of grayish gneiss which represent the Grenville series in this district, there are also masses of anorthosite and granite, which, from their relations to the gneiss and limestones, are clearly intrusive in and newer than these. The outlines of some of these masses have already been given in the map referred to. The strikes of the gneiss are generally to the north or north-west, and the angles of inclination are low. The banded gneisses are thrown into a series of low undulations, and there are several narrow bands of crystalline limestone. These, however, cannot be traced continuously to any great distance on their strike, but disconnected outcrops appear at intervals which may represent portions of bands that may at one time have been continuous, but which through denudation or from other causes, have disappeared over long distances. Throughout this area, there is a marked similarity in the characters of the gneiss, to what is observed in the gneiss and limestone areas of the Grenville district, north of the Ottawa. The descriptions of the various rocks found in this district are so fully given in the report by Dr. Adams, * that further reference is unnecessary here.

Gneiss of the Grenville series.

Crystalline limestone.

A reference has also been made by Dr. Adams in the report just alluded to, to the area of granite that occurs near the centre of the sheet and to the north-west of Lake St. Peter. This area was outlined first by Mr. R. G. McConnell in 1880, and its boundaries were subse-

The great granite area.

* Annual Report, Geol. Surv. Can., vol. VIII, (N.S.), 1895, pp. 11 to 30 J.

quently revised in part by Mr. Giroux in 1891 and 1893. While other areas of similar rock are recognized at different points in the area under consideration, this is by far the most important as yet seen. It is somewhat irregular in outline, and has a length of about twenty-eight miles from the south-west angle in Berthier to its north-east end in the township of Belleau in the county of St. Maurice, and with a maximum breadth of about fourteen miles in the townships of Hunterstown and Decalonnes.

Character of the granite.

The granite varies in character at different points. Sometimes it is coarsely crystalline and massive, with but small traces of foliation, while at other points it is fine-grained and a well-marked foliation is observable. It occupies a large part of the townships of Berthier, Decalonnes and Hunterstown, as also of the Fief Hope which is a portion of the township of Lanaudière. Its south-west extremity is in the shape of a long narrow tongue, the width of which must be somewhat conjectural, since it is largely concealed by the drift of the St. Lawrence basin.

Granite and anorthosite.

In the vicinity of this granite mass are other smaller intrusions of anorthosite and granite in the counties of St. Maurice and Maskinongé. In their relations to the surrounding rocks of this area, these granites and anorthosites are also of more recent date, since at a number of places they are noticed as cutting off the gneiss across the strike, while on either side of the main mass to the south of St. Gabriel de Brandon, the presence of the granite has changed the strike of the surrounding gneiss, so that the latter now follows the general outline of the granite mass. The petrographical features of these rocks have been fully discussed by Dr. Adams in his report, previously referred to, p. 31 J.

Rocks of the Grenville series.

Generally speaking, therefore, the rocks of the greater portion of the map-sheet, excepting the Palæozoic formations, may be regarded as representing the portion of the Grenville series beneath the crystalline limestones, which are but sparingly represented. In the Grenville district the calcareous members are found to occupy largely the synclines in the underlying gray quartzose gneiss. While a similar structure as regards the presence of anticlines and synclines is found in this area, there is this difference, that in the St. Maurice portion the gneiss layers and undulations are in a much more nearly horizontal position than in the Grenville area where the strata are generally highly inclined. The calcareous members, therefore, if they ever were deposited in the former area as seems probable from the scattered remnants of that portion of the series now found, have probably to a large extent been removed by denudation. The gneisses seen are, for the most

part, of the altered sedimentary series, rather than pertaining to the lower or what has been styled the Fundamental Gneiss of the Laurentian.

SURFACE GEOLOGY.

Allusions have already been made in the preceding pages to certain surface deposits of sand and clay found throughout the area comprised in the accompanying map-sheet. Near the St. Lawrence River the broad and nearly level plain which extends for some miles, both to the north and south of that river, is occupied almost entirely by these deposits. In these, marine shells are rarely seen, but sometimes occur in the overlying sandy beds. In this respect these deposits very closely resemble those found along the lower Ottawa and between that river and the St. Lawrence above Montreal, where the occurrence of marine shells in the gravels overlying the clays is a very common feature, while the clays themselves are for the most part without visible organic remains.

Marine shells in sand above the clay.

The clay deposits in the St. Maurice district underlie the sands along the river courses for many miles north, and in some places to the height-of-land. The overlying sands are seen in the flat country near the St. Lawrence as well as in the more elevated areas to the north. Nearing the height-of-land, the surface of the country becomes much more level and is largely covered with sand and gravel over which boulders of gneiss and granite, often of large size, are sometimes strewn. In none of these northern deposits have we yet been able to find marine shells. Along the large streams well-defined terraces are common. Of these there are generally four, the upper of which has an elevation of about 150 feet above the adjacent stream, and these can sometimes be traced for miles. Along the shores of many of the inland lakes the deposits of sand and water-worn stones sometimes form banks up to fifty feet or more in height.

Absence of marine shells in upper St. Maurice terraces.

Glacial striæ are not numerous. In the gneiss area the rock does not readily retain these, though grooves are sometimes seen, while the Palæozoic formations are for the most part so covered by drift that rock outcrops are rarely met with. The general direction of those noted is from north to south or toward the St. Lawrence from the height-of-land. The course of the ice, judging from the striæ, has been to some extent influenced by the topographical features of the country. Thus on the Batiscan River, Mr. A. P. Low records several between the crossing of the Lake St. John railway and the village of Ste. Geneviève where the rocks become concealed by drift, which range

Glacial striæ

from S. 10° to 20° E. Along the line of railway to St. Tite junction the same apparent course is maintained. At Grandes Piles on the St. Maurice River, the course of the striæ is about south, and below that place towards the city of Three Rivers it varies from S. 15° to S. 40° E.

On Big Long Lake it is S. 40° E., on Lake Mekinac S. 20° E. and on Lake Roberge S. 10° W., while at the mouth of the Rat River, on the St. Maurice, which is just above the limit of the map-sheet, the recorded course is S. 30° W.

Glacial grooves.

West of the St. Maurice, there are few recorded markings. On the upper Mattawin grooves were noted at two places, the course of which was very nearly north-and-south. Near Ste. Ursule, Mr. Giroux records two exposures showing north-to-south striæ, and a little to the south of St. Gabriel de Brandon village, an exposure shows striæ with a course S. 35° E. Near the village of Ste. Emilie striæ are recorded as S. 15° W.

Shore-lines.

Shore-lines were noted by Mr. R. Chalmers at a number of points in this area. Of these the highest recorded by him was at Lake Maskinongé with an elevation of 865 feet and on the St. Maurice at 670 feet, above sea-level. Other shore-lines doubtless exist but are difficult to trace owing to the dense forest growth of this upper country.

A supplementary chapter on the clay-deposits of the St. Lawrence area, with special reference to the remarkable landslides near the Rivière Ste. Anne de la Perade, by Mr. Chalmers., is appended

ECONOMIC MINERALS.

Full notes are given of the economic minerals found in the area west of the St. Maurice, in Dr. Adams's report previously referred to pp. 140-154 J.

Iron-ores.

The most important mineral deposits yet found in the St. Maurice district are those of bog-iron ore, which have been worked almost continuallv for a century and a half. The history of these workings has been given at considerable length in the writer's report on the Mineral Resources of Quebec,* and need not here be repeated. The mode of working the deposits has been entirely remodeled within the last ten years, by the erection of a new and modern smelting plant, including blast-furnace, coke-ovens and other appliances for obtaining and smelting the ore which is disseminated over a very large extent of

* Annual Report, Geol. Surv. Can., vol. IV, (N S.) 1888-1889, part K.

country both to the north and south of the St. Lawrence. Reference is made in the Summary Reports of Messrs. Low and Giroux for 1891-92 to some of the principal sources of supply of the ore. Of these one of the most important is at Lake Tortue, where the material is largely obtained by dredging from the lake bottom by machinery specially constructed for that purpose. The waters of this lake have also been lowered about four feet so that a large amount of the ore can be obtained by digging. In this connection we may quote from the statement of the Radnor Iron Co. in the Canadian Mining Manual, 1898.

The Radnor Iron Co.

'The company at present owns an area of 100,000 acres of bog-ore rights in the districts of Champlain, St. Maurice, Three Rivers, Vaudreuil, Joliette, St. Ambrose de Kildare, Pointe du Lac, Gentilly and Bécancour, including the important deposits (supposed to be the largest of like nature in the world) of lake ore in Lake Tortue and Lac au Sables.

Lake Tortue.

'Lake ore is raised principally at Lake Tortue, where a steam dredge of a capacity of fifty tons a day is employed. The deposits vary somewhat in analysis; some of the bog-ores used by the company being as low as ·080 sulphur and ·042 phosphorus.

'The lake iron ore is found scattered over the bottom of the lake in an unctuous light-coloured mud made up of decayed vegetable matter. The ore does not appear to be found deeper than twelve or fifteen inches below the surface of the bottom and is most plentiful in the upper parts of the mud. It occurs in the form of porous, flat, rounded concretions, very irregular in colour. The concretions vary from a fourth to twelve inches in diameter and from a fourth to two inches in thickness, and closely resemble the dried excrement of cattle. The country surrounding Lake Tortue is almost flat, being a great swampy plain underlain by stratified clays, and covered in many places by extensive swamps. The underlying sands are highly impregnated with oxide of iron, derived from the decomposition of the rocks in the neighbourhood, which are highly charged with titaniferous iron ore. The iron in these sands is leached out by the action of acids, and fresh ore is being constantly formed, so much so that paying quantities of ore have been obtained from parts of the lake bottom which had been worked over thoroughly only a few years previously. As the lake is quite shallow and the depth increases slowly from the shore, the whole bottom can be worked over by the dredge belonging to the company. The dredge is of the endless chain pattern, with four rows of buckets. The buckets bring up the ore mixed with large

Ore of Lake Tortue.

Method of collecting.

quantities of mud, which they empty into a long cylindrical sieve, having rows of water jets inside. The sieve is slowly rotated and the ore tumbling through is washed clean and discharged on scows moored alongside, and then towed to the railway at the west end of the lake, The company has lowered the level of the water several feet, exposing a wide margin of the deposit, which is worked by hand. This is shovelled into round iron sieves and the ore washed out and made into heaps along the shore.'

Forges at Fermont.

The company's forges and plant, with the exception of the coke ovens at Grandes Piles and Lac au Sables, are situated at Fermont on the Rivière au Lard. The furnace has a capacity of forty tons a day of high-class charcoal iron which is specially suited to the manufacture of car-wheels. The furnace stack has a height of forty feet, bosh eight feet in diameter, crucible five feet in diameter, height of bosh line from hearth, eleven feet, with four tuyeres of three and a half inches diameter, the crucible and bosh being protected by a water-jacket. The furnace top is provided with a bell and hopper, having a capacity of twenty-five bushels.

This plant is fitted with the most modern appliances in the matter of hot-blast stoves, blowing engines, &c. The output of charcoal iron for 1897 was 8,512 tons, for which 836,000 bushels of charcoal were made.

Other ore-deposits.

The Radnor Company, in addition to the ore-deposits west of the St. Maurice, obtains a certain amount of bog-ore from the vicinity of Joliette, on ranges III. and IV. of that township, in the parish of St. Ambrose, where a somewhat extensive deposit of this ore is found. A small deposit of magnetic ore has also been worked on the concession St. Charles, in the Parish of Ste. Ursule. Other deposits of bog-ore were noted by Mr. Giroux at various places in the area west of the St. Maurice, but the extent of all these appeared to be small.

Mica deposits of the Mattawin district.

The deposits of mica on the upper part of the Mattawin have already been noted by Mr. Giroux.* They have also been referred to on a previous page. No work has been done in this direction for a number of years, and they do not appear to possess much value at the present time. At other places in this northern area, crystals of mica were seen in connection with some of the pegmatite veins, but no attempt has ever been made to determine their economic value and their present inaccessibility is against their development.

* Summary Report, Geol. Surv. Can., 1892, p. 43.

The iron ochre on the Milieu River is situated about three miles and a half north of Pine Lake, which is on the upper part of the Mattawin River. The material is of two colours, a vandyke brown and an indian red. Several tons were shipped some years ago to Montreal by the owner of the property, Mr. Gaucher, but the distance to railway, about sixty miles by the Brassard road, is against its profitable development. Iron ochre of the Milieu River.

The ochre deposits near Three Rivers, which have been worked at intervals for forty years, are still worked by the Canada Paint Company and the Champlain Oxide Company. The output is variable apparently from 1,000 to 1,500 tons of ochre per year. Ochre near Three Rivers

Infusorial earth is found at two places in the area west of the St. Maurice. One of these is in the concession Trompe Souris, of the Parish of St. Justin, where it occurs in small quantity at a few feet below the surface in a sand-bank, sixty to seventy feet high, and near a small ravine. The other deposit is on lot 15, R. V., Chertsey, at the bottom of a marshy bay on Lac Michel, and has an area of three to four acres, with a thickness of eighteen inches. Infusorial earth.

Quarries of excellent limestone for building purposes are found at several places in the Palæozoic formations. They are located for the most part in the Trenton formation. Of these the principal are near the town of Joliette, which is just south of the limit of the map-sheet. The others are Barrette's quarry, near St. Barthélémi, Berthier county, Gagnon's quarry, near the village of St. Justin, Maskinongé county, Fafard's, Defond's and McGee's quarries, near St. Cuthbert, and Robillard's quarry, about four miles north-east of Joliette. Along the Chaloupe River also there are large exposures of lower Trenton limestone, which should furnish good material for building and lime-burning. Limestone quarries.

At the Radnor forges, Fermont, there is a good outcrop of apparently Trenton limestone, which has been quarried for local use, and should afford a good quarry site. From none of these localities were any details as to output obtained, and all are worked apparently for local consumption only.

Borings for natural gas were made some years ago near the villages of St. Justin and St. Barthélémi, north of the St. Lawrence. Gas was found in small quantity at a depth varying from sixty to eighty feet from the surface, but the borings were apparently not carried to a depth sufficient to establish any conclusions as to the actual value of the area as a producer of this material. These borings probably started in the Trenton limestone. Natural gas.

The borings on the south side of the St. Lawrence have already been incidentally referred to. They have been described by Mgr. Laflamme in a paper to the Transactions of the Royal Society of Canada in 1887, Vol. VI., and have also been discussed by Mr. Obalski, in a report of this area in 1885. The results of the work done in this district are given in the report by Dr. Selwyn in vol. III. 1887–88, pp. 33-34A. In the deepest hole which was put down in the vicinity of St. Grégoire, Nicolet county, the boring started in the red shales of the Medina formation, which were found to have a thickness of 655 feet at this point, and were continued downward in the underlying Lorraine shales and thin limestones to a further distance of 540 feet. It would appear that the Utica shales were not penetrated nor was the underlying Trenton reached, which was supposed to be the true source of the gas. Gas was, however, struck at a depth of 68 feet from the surface and an abundant flow at a depth of 640 feet, the latter sufficient to hurl mud and stones to a height of sixty feet into the air. When the hole was abandoned at a depth of 1115 feet, the gas continued to flow with such force that the orifice was not closed and at the last accounts the bore-hole was still discharging gas. It is to be regretted that this boring was not carried down to the top of the Trenton formation, so that some definite information as to the thickness of the formations in this area might have been obtained and important facts as to the probabilities of gas in this part of the St. Lawrence valley secured.

Boring near St. Grégoire.

NOTE.—In a recent report by Mr. Obalski, Inspector of Mines for Quebec, upon a boring made in 1899, near St. Grégoire, very salt water is stated to have been found at a depth of 605 feet, but no gas in economic quantity was struck.

APPENDIX I.

NOTES ON THE PLEISTOCENE MARINE SHORE-LINES AND LANDSLIPS OF THE NORTH SIDE OF THE ST. LAWRENCE VALLEY.

BY ROBT. CHALMERS.

Extent and elevation of the marine plain on the north side of the St. Lawrence River.

The marine plain or bottom land of the St. Lawrence valley on the north side of the river between Quebec and Montreal, is of irregular extent, in some places being only eight or ten miles wide, in others twenty or thirty. The height of the plain seldom exceeds fifteen or twenty feet along the river bank, but it increases to 400 or 500 feet at the northern limits which usually rest on the base of the Laurentide hills. The junction of the plain with these hills forms a very irregular line often running up the river valleys in loops for considerable distances. Generally speaking, this line can be traced approximately on a good map from the absence of lakes on the marine area, whereas on the Laurentian area lakes are quite numerous. Occasionally the surface of the plain is seen to ascend by steps proceeding from the St. Lawrence River to the base of the hills, each of these steps having apparently been a shore-line for some length of time at a certain stage of the emergence of the valley from beneath the sea.

Terraces and shore-lines.

Skirting the inner border of the plain along the hill slopes, terraces and ancient beaches occur which were evidently sea margins, or shore-lines, during the Pleistocene subsidence of the region. The altitudes of these have been measured in a number of places.

The Saxicava sands and deposits which constitute these uppermost shore-lines or beaches, merge almost imperceptibly into the sands and gravels of the higher levels, often quite thick, which occupy the valleys among the Laurentide hills.

Height of shore-lines; how measured

The elevations of the shore-lines observed within the area of the Three Rivers map-sheet of the 'Eastern Townships series' are here given. They are based on the profile heights of the Canadian Pacific railway, and referred to mean sea-level. The only instruments used were aneroids, and the results must, therefore, be regarded as mere approximations, more especially as a number of the points levelled are situated at considerable distances from the railway. To correlate the shore-lines in the particular district in question with those of which

the heights have been measured to the east and to the west, we shall commence at Quebec city and follow them westward to Lachute on the north side of the Ottawa River.

Shore-lines at Quebec.

1. North of Quebec, on the Charlesbourg road, two shore-lines were observed. The first and lowest occurs at Charlesbourg village, at a height of about 450 feet. The higher one was found about six miles from Quebec at 560 feet. Both are well-defined.

At St. Ambrose.

2. Near St. Ambrose, on the old Quebec and Lake St. John railway, Mr. A. P. Low, of this survey, discovered Pleistocene marine shells in Saxicava sand at an elevation of 515 feet above the level of the sea. * In the vicinity terraces of this sand were observed at a height of about 600 feet.

North of Portneuf.

3. North of Portneuf station, Canadian Pacific railway, on the road to St. Eustache, well marked shore-lines were found at 350 to 360 feet, and at St. Raymond at about 475 feet. To the north of this village they were noted at a height of 600 feet or more.

At St. Tite.

4. At St. Tite village sand and gravel terraces occur at about 670 feet. These are continuous with and apparently form part of the St. Maurice sands, so extensively developed in the valley of St. Maurice River, and well known as a marine deposit.†

Ste. Flore.

5. At Ste. Flore, on the west side of the St. Maurice River, a shore-line was found at 565 feet, and a higher one seen on the flanks of the hills to the north, which, however, could not be reached at the time of my visit.

Near Lake Maskinongé.

6. South of Lake Maskinongé, in the vicinity of St. Gabriel de Brandon, terraces and benches were observed at the following points:—

Near St. Gabriel station, Canadian Pacific railway, a well-defined terrace at 675 feet.

To the south-west of the last, another terrace or bench at 725 feet.

Further to the south-west a third was noted, which at two or three places was found to be 825 feet high; while still further up the slope a fourth occurs at 865 feet, but imperfectly defined and not continuous for any distance.

The Laurentide hills here rise to altitudes of 1000 feet or more, and the terraces flank them, facing the marine plain of the St. Lawrence valley.

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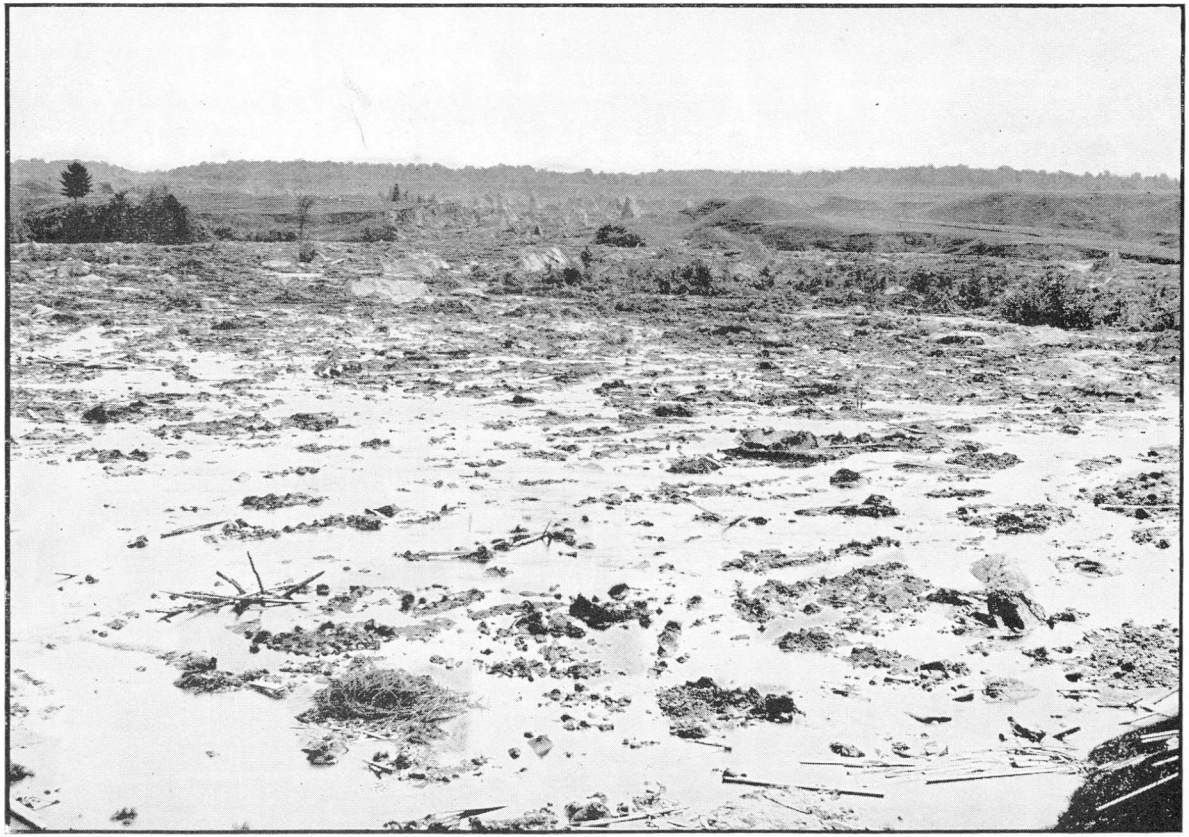
*Annual Report, Geol. Surv. Can. vol. V., (N.S.) 1890-91, p. 55 L.

†Geology of Canada, 1863, page 887.



VIEW OF LAND-SLIDE IN RIVIÈRE BLANCHE VALLEY AND OF NARROW OPENING THROUGH WHICH IT ISSUED.

7. On Mount Royal, Montreal, Pleistocene marine fossils have been found, as is well known, up to a height of 560 feet, and 'Dr. F. D. Adams and Baron De Geer observed a distinct beach at about 615 to 625 feet.'* At Mount Royal.

8. On the road leading from St. Jérôme to Ste. Camille good shore-lines were seen at the following elevations :— Ste. Camille.

(1) A well-defined terrace at..... 700 to 725 feet.
(2) A second at ..... 760 to 765 "
(3) A third and the highest seen here, distinct in places, but not continuous, at 895 feet.

9. To the north of Lachute a terrace occurs at 745 feet, which may represent a shore-line. East of Dunany, on the road to Shrewsbury, however, great gravel mounds and terraces were observed at 845 feet; while to the north of this and about ten or eleven miles from Lachute station, Canadian Pacific railway, an extensive, horizontal sand and gravel terrace, composed of water-worn materials occurs. Several kettles, holding small lakes, such as are seen in the Saxicava sands of Three Rivers in the St. Maurice valley, were observed in this terrace, and in some places kame-like ridges occupy its surface. Height 975 feet. North of Lachute.

No barrier exists between these terraces and the open St. Lawrence valley.

From the foregoing facts it will be seen that the shore-lines increase in height from east to west, the average gradient of the highest between the city of Quebec and Lachute being about two feet per mile. They have not been traced continuously, however, even within the limited distance included in the Three Rivers map-sheet, as the hill slopes were in many places found to be covered by forest at the time of my examination. The maximum upheaval is, nevertheless, believed to be shown by the highest of the shore-lines given in the above record of observations, and its differential character may be considered as established. Average gradient of shore-lines.

Landslips.

A remarkable landslip happened in the Rivière Blanche valley, Portneuf county, in the province of Quebec, on the 7th of May, 1898. This landslip destroyed a large portion of three farms with the buildings thereon, and the quantity of material which was discharged into the river valley was so great as to fill it to a depth of twenty-five feet or more for a distance of nearly two miles. The people living on the Rivière Blanche landslip.

*The Ice Age in Canada, p. 63. By Sir J. Wm. Dawson.

farms which were damaged had to flee for their lives, all escaping but a little girl who was buried in the débris. This catastrophe occurring so soon after the one which took place at St. Albans, on the Rivière Ste. Anne de la Pérade, directed attention to these peculiar phenomena, and some investigation as to their character and causes seemed to be necessary. Accordingly, Dr. Dawson, Director of this Survey, having first made an examination of the Rivière Blanche landslip instructed the writer to proceed to St. Thuribe and further investigate this and the landslip at St. Albans and report thereon. Mr. J. Keele accompanied me and carried out the work of measuring the area of the former and photographing its principal features.

Three landslips of considerable magnitude have been known to occur in this part of the St. Lawrence valley within the past sixty years, and evidences of others, of which there is no account, were observed.

Maskinongé landslip.

The first of those referred to, took place on the bank of Maskinongé River, about nine miles to the south of the granite hills, on the 4th of April, 1840, and was examined and described by Sir W. E. Logan*. The area affected was about 84 acres and the chasm is described as oblong in shape, with the narrow funnel-like end towards the river. The total length was about 1,300 yards, while the breadth varied, the widest part equalling 600 yards. When examined by Sir W. E. Logan, the bottom of the widest part of the pit was found to be thirty feet below the level of the surrounding country. The material transported into the valley of the Maskinongé River filled it to a depth of 75 feet for a mile and a half. The cause of this landslip, Logan believed to be pressure on an inclined plane, assisted by water although no subjacent rock-surface was seen.

St. Albans landslip.

The St. Albans landslip occurred on the 27th of April, 1894, on the west bank of the Ste. Anne de la Pérade, about four miles above the village of St. Albans or seven miles distant from the Rivière Blanche landslip. Here the deposits (Leda clay and Saxicava sand) slid down bodily into the valley of the river for the space of three miles and a half. The landslip seems to have been in three parts, the first movement being at the northern end, where it was about ten feet deep. This was followed, after some hours, by another which took place immediately to the south of the last; and finally a third descended, just below the second, leaving a pit, 175 feet deep. The average depth of the whole chasm was not less than 100 feet below the general surface of the ground, and its width about a mile. The mass of material

* Proc. Geol. Soc. of London, vol. III, 1838-42, pp. 767-769.

thrown into the valley of the Ste. Anne permanently changed the course of the river.

This landslip has been described by Mgr. Laflamme of Laval University, Quebec,* and by Messrs. Archibald and Mackenzie of the Chief Engineer's Office, Intercolonial railway, Moncton, N.B.† Published descriptions.

The Rivière Blanche landslip was closely similar to that of Maskinongé River, described by Logan. As stated above, it took place on the east bank of the Blanche, a tributary of Ste. Anne de la Pérade, at St. Thuribe, about three miles north of St. Casimir village. The banks of the latter river are low and the country flat, forming part of the St. Lawrence plain, as far up as St. Thuribe, where the valley is crossed by a boulder-clay ridge. The superficial formations consist of Saxicava sand and Leda clay and boulder-clay. In the pit where the landslip occurred the Leda clay is prolific in marine shells, chiefly *Leda arctica* and *Macoma Grœnlandica.*

The chasm remaining from this landslip is also irregularly oblong in shape, like that of the Maskinongé valley described by Logan, with a narrow opening at the end towards the Rivière Blanche. At this point the breaking down of the beds began, and through this opening the whole of the flowing material of the landslip was discharged. The length of the pit, east and west, is about 1,050 yards, extreme width, 600 yards, maximum depth, about 28 feet; total area, 86 acres. The descent of the bottom throughout its whole length is approximately 27 feet, or about ten inches to the hundred feet, and the gradient is comparatively uniform from the eastern end to the present bottom of the river.

The movement of clay and sand on such a low gradient, it is obvious, could only have taken place when these materials were in a semi-liquid condition, and from all accounts the landslip resembled the bursting of a reservoir of water. Those who witnessed it, however, informed me that very little water was seen, the flowing mass consisting of a very soft clay or mud. Indications of a movement in the clays were first seen on the evening of the 6th of May in a small hollow in the bank down which a trickling stream ran, but no attention was paid to it. Up till the hour when the landslip actually commenced, the people who lived on the ground that was swept away crossed it by the highway and went in and out of their houses without any thought of the impending catastrophe. About five o'clock on the Description of Rivière Blanche landslip.

* Trans. Roy. Soc. of Canada, vol. XII. 1894, p. 63.

† The Railroad Gazette, New York, U.S., June 29, 1894.

morning of the 7th, the breaking away of the clay beds began where some slipping had been noticed on the previous evening. Very soon the movement seemed to gather force and work backward through the drier and harder clay in the immediate bank of the river, inside of which it expanded on both sides into the terrace. The softer material flowed out from beneath, while the upper and more coherent clay split off in vertical sheets and columns which were borne away in the sliding, surging mass. This continued for upwards of three hours, when the transporting power seemed to have spent itself, and great masses of clay which had become detached from the walls of the chasm stranded in its bottom, and at the time of my examination were seen standing in various positions, some of them resembling cones, pyramids, etc.

Character of deposits.

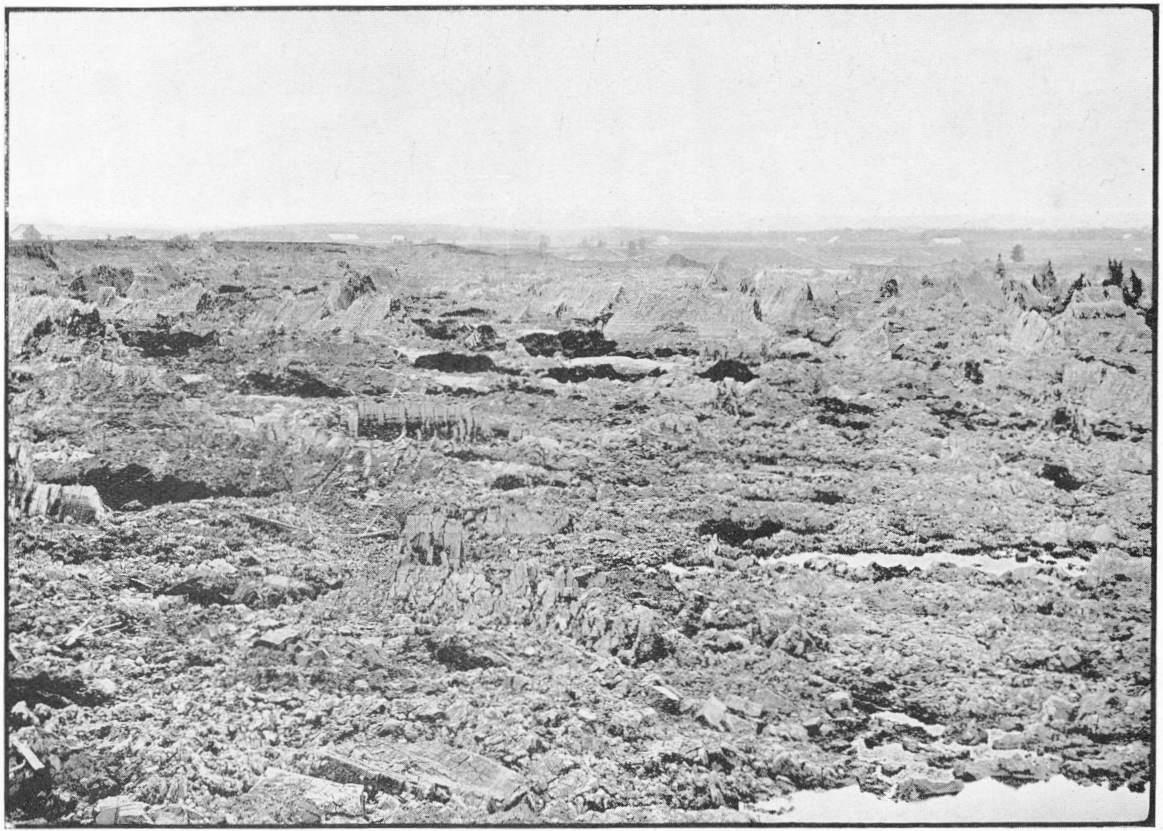
The marine deposits in which this landslip occurred are quite arenaceous and silty, especially in the upper part, and no well-defined break was seen to exist between the Saxicava sand and Leda clay, the one graduating into the other. Hence the surface waters percolate downwards to a considerable depth during the period of snow-melting every season. According to the following analysis of three samples of the clay taken from this pit in the laboratory of the Geological Survey, by Mr. R. A. A. Johnston, it was found capable of carrying, when saturated, from 22 to 25 per cent of its own weight of water.

It appears also form the observations taken at the Meteorological station at Quebec, furnished by Mr. R. F. Stupart of the Meteorological Service, that during the winter of 1897-98, the snowfall was heavy, particularly in the month of February, with more than the usual amount of rainfall in May, the precipitation for February exceeding the average for twenty-four years by 2·00 inches, and for the month of May by 0·39 inches.

Rain and snowfall.

TABLE giving the Rain and Snowfall, also the total Precipitation for the undermentioned Months at the City of Quebec.

—	1897.		1898.				
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
Rainfall in inches.....	2·07	1·15	0·00	0·70	2·42	1·10	3·55
Snow in inches.....	12·7	12·2	31·5	44·2	3·0	2·0	0·0
Difference from average snow of 24 years..... ..	— 5·2	—16·7	— 1·4	+17·9	—19·9	—7·0	—1·0
Total precipitation.....	3·34	2·37	3·15	5·12	2·72	1·30	3·55
Difference from average total ppn. of 24 years ..	— 0.52	— 1·45	— 0·97	+ 2·00	— 0·48	—0·93	+0·39



VIEW OF SURFACE OF DEPRESSION CAUSED BY LAND-SLIDE, LOOKING TOWARD OUTLET.

CLAYS from site of Landslide on the Rivière Blanche, a tributary of the Ste. Anne de la Perade, Portneuf county, Province of Quebec.

No.	Clay from	Specific gravity.	Weight of one cubic foot.	Composition.			Absorbtive power.*	Water absorbed by one cubic foot.	Percent of water in saturated clay.
				Argillaceous matter.	Silt.†	Water at 100 C.			
			Lbs.				Percent.	Lbs.	
1	Bank on north side of pit.....	1·923	120·2	47·3	32·4	20·3	2·5	3·0	22·2
2	Bank on east side of pit.....	1·904	119·0	32·3	44·9	22·8	0·2	0·2	22·9
3	Upper clay on north side of neck or opening.	1·911	119·4	27·0	52·7	20·3	7·0	8·4	25·5

* Namely amount of water absorbed in addition to that already contained in it.

† Silt of clay No. 1 consisted of finely divided quartz and felspar with some minute scales of mica and a few particles of magnetite.
" No. 2 " " " " " calcite and magnetite.
" No. 3 " " " " " magnetite.

N.B.—Experiments conducted by Mr. R. A. A. Johnston.

Analysis.

This excess of water passing into the silty and arenaceous clay and sand must have given the beds greatly increased weight. It is probable also that a zone or layer of softened clay of some thickness was thus produced beneath the arenaceous strata, and held in by an impermeable hardpan below, and by the hardened clay banks on the riverward side and on the north, where a depression exists, supposed to be the seat of an ancient landslip. The depression referred to was noted by Dr. Dawson, on the occasion of his visit to St. Thuribe. The walls are now broken down and the inequalities which must have once been in the bottom reduced. This pit appears to have had very nearly the same dimensions as those of the recent landslip, with a similar narrow outlet in the river's bank through which the material was doubtless discharged into the Blanche valley.

Old landslip at St. Thuribe

In a paper read before the Geological Society of America at the meeting held in New York in December, 1898, Dr. Dawson presented the principal facts respecting the Rivière Blanche landslip, with illustrations, under the title of a "Remarkable Landslip in Portneuf county, Quebec," and briefly described those landslips which had previously occurred in this part of the St. Lawrence valley. This paper was published by the Society.*

Mgr. Laflamme, of Laval University, Quebec, also examined the Rivière Blanche landslip, subsequent to the date of my visit, and reported the result to the Commissioner of Colonization and Mines, for the province of Quebec.† He states that an absolutely similar phenomenon happened two or three years ago in the parish of St. Luc, Champlain county, along the Champlain River. As at St. Thuribe, a considerable volume of clay issued through a narrow opening, covered rich alluvial surfaces and blocked the river. Nevertheless the phenomenon at St. Luc was on a very much smaller scale.

Landslip at St. Luc.

The causes of the Rivière Blanche and other landslips of this part of the St. Lawrence valley seem to be:— (1) the silty and arenaceous character of the Leda clay, rendering it capable of absorbing and retaining a large amount of water, and (2) the increased precipitation during the seasons when these landslips occurred, which saturated the deposits and gave them greater weight than usual. These conditions doubtless produced unstable equilibrium of the beds, resulting in displacement and a flow of the semi-liquid portion. The more coherent clays, breaking down as described, and mixing with the soft material, produced a tumultuous mass of mud, clay and sand, which descended into the nearest valley.

Probable causes of landslips.

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*Bulletin Geol. Soc. Am. vol. X, 1899, pp. 484-490.

†Report of the Commissioner of Colonization and Mines for 1898, p. 131.