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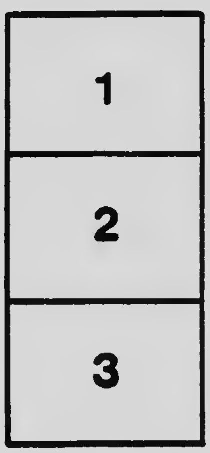
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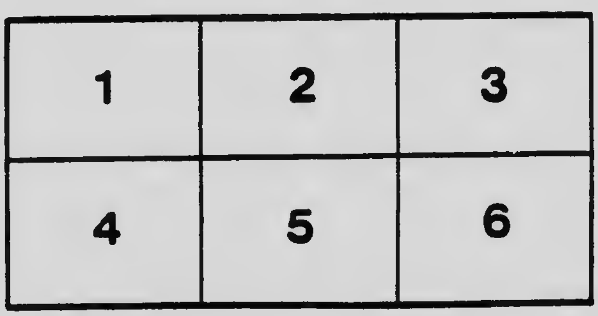
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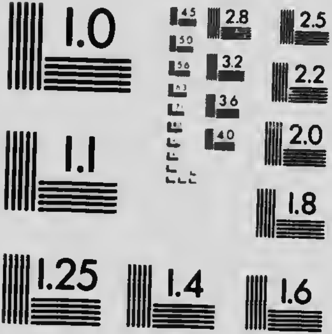

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GEOLOGICAL SURVEY

MEMOIR 73

No. 58, GEOLOGICAL SERIES

The Pleistocene and Recent Deposits of the Island of Montreal

BY

J. Stansfield

OTTAWA
GOVERNMENT PRINTING BUREAU
1915

No. 1487

View of Mour   'oy

PLATE I

'oyal from the southeast.

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PREFACE.

The chief part of the information upon which this report is based was gathered during the field season of 1913, some of it in 1912. In addition to direct observations, information has been obtained at second hand from a great many people, more especially within the City of Montreal. I wish to express my thanks to the many construction engineers and contractors, who have willingly proffered such information as to the thickness and character of the drift overlying bed-rock, as they had gathered in the past, and which was obtainable in no other way. To the courtesy of the city officials of Montreal, Westmount, Outremont, and Maisonneuve, my best thanks are due for supplying such information, and also details of bench-marks.

Dr. F. D. Adams placed in my hands notes taken from time to time during the past years; Messrs. Milton Hersey Co. Ltd., have allowed me to make use of their report on the deposits at the filtration plant, which was in course of construction in 1913; Mr. J. Keele of the Geological Survey has sent to me his report on the physical characters of the Leda clay at Lakeside; and Mr. E. Ardley has given me much information regarding exposures, now no longer to be seen; to these gentlemen my warmest thanks are tendered for their help.

All work on the Pleistocene of the St. Lawrence valley must, of necessity, be based upon the extensive and excellent work done by Sir J. W. Dawson. He it was who established the main subdivisions of the Pleistocene, and who made the study of the fauna of the Canadian Pleistocene especially his own field. The faunal lists for the Leda clay and Saxicava sand have been taken from his 'Canadian Ice Age,' and only two or three additions have to be made to the lists obtained from that source.

With regard to the beach elevations, it may be stated that they were obtained by levelling from and to city or railway bench-marks, using a hand-level mounted on a tripod. Care was taken to have the distances covered as short as possible and to use only such bench-marks as had been checked within the last few years. The checks on the levels thus run were usually very close, so that the elevations are confidently given as correct to the nearest foot.

It should be noted that within the city limits of Montreal, Westmount, Outremont, Maisonneuve, and Montreal West, the terms north, south, east, and west, are used in this report with the usual significance that is given to them in the city, i.e., that St. Catherine street runs east and west (actually it runs northeast and southwest), and that St. Lawrence street runs north and south. It is considered that adherence to this established practice will be of greatest use to the public for whom the report is intended, and will cause no confusion in the recording of information in the future. For the remaining part of the island, not specified above, the terms north, south, etc., will be used with their true significance.

The Pleistocene and Recent Deposits of the Island of Montreal.

CHAPTER I.

INTRODUCTION.

GENERAL GEOLOGY.

For the purposes of this report the geology of the Island of Montreal may be said to fall into two sharply marked divisions. The first includes the Pre-Cambrian and Palæozoic subdivisions of the earth's history, and to these two can be referred the "bed-rock" of the island. The second includes the deposits of the Pleistocene and Recent periods. The rocks of the former division are of great geological age, and since their formation they have been consolidated into rocks of such cohesion that they can be used for structural materials without any further treatment than dressing. The rocks of the latter division are in practically the same condition as when they were formed, and here it may be mentioned, that a bed of unconsolidated sand is a rock in a geological sense.[1] They have been subjected to practically no changes beyond alteration of level in relation to sea-level. The deposits of the two divisions are, therefore, easily distinguishable from each other. Of the later Palæozoic, the whole of the Mesozoic, and the greater part of the Tertiary eras there are no records. If any deposits were formed in those times they have been totally removed so as to leave an unknown blank between the Devonian and Pleistocene periods. It is known, however, from the drowned valleys of the Atlantic coast, that the elevation of the land relative to sea-level was greater than now at some period shortly before the Pleistocene, possibly in Pliocene time.

[1]A. Geikie, Textbook of Geology. Fourth Edition, 1903, p. 82.

The deposits of the Pleistocene and Recent periods, loosely described by the collective term "drift," allow of separation into divisions which are at the same time lithological and chronological, as follows:

Recent....................	Lake deposits, including lake clays, shell marls, and peat.
....	River gravels.
Pleistocene................	Saxicava sand and gravel, with shore-ice deposits.
....	Leda clay.
....	Boulder clay.

These deposits lie upon the Palæozoic or Pre-Cambrian rocks, unconformably. The mode of formation of the boulder clay has been a subject for controversy, the writers on the subject falling into two sharply marked classes, viz., those who upheld the theory that it is a deposit which was laid down on the floor of the sea as material transported by icebergs, and dropped by them at such places as melting ensued, and those on the other hand, who consider the boulder clay of North America to be a deposit formed by the agency of a continental ice-sheet, acting upon land-surfaces, wearing them down, and transporting and afterwards depositing the unsorted material in sizes varying from large blocks the size of a house, down to the finest rock flour.

Without entering further into a discussion of this controversy, it may be taken as the general geological opinion of the present day, that the latter explanation applies to the greater part of the boulder clay of North America, but it cannot be denied that during a part, at any rate, if not the whole, of the time represented by the boulder clay, that the sea had access to a part of the St. Lawrence valley, as the presence of marine shells in the boulder clay of the lower St. Lawrence testifies.

If we consider the higher lands of pre-Pleistocene time, as deduced from the drowned valleys of eastern North America, to have afforded the collecting grounds for such masses of ice as are rendered necessary by the idea of the continental glacier, then without attempting to fix the limits of thickness of such an ice-sheet[1] according to the principle of the maintenance of the isostatic equilibrium of the earth's crust, readjustment of level must have ensued owing to the loading of the surface with ice, i.e., the land surface must have been depressed relatively to sea-level. We learn that isostatic readjustments usually lag behind the impulses causing them. So that the collection of a thick ice-mass would be followed, but not immediately, by a depression allowing of a marine transgression. Such a marine transgression is represented by the Leda clay; and a moment's consideration will suffice to show that the gradual encroachment of the sea, say, up the St. Lawrence valley, would cause only a gradual displacement of the conditions favourable to deposition of boulder clay. So that in areas characterized by this marine transgression we should expect to find a *gradual* and not a sharply marked change from typical boulder clay to typical Leda clay deposits. The presence of marine fossils in the upper part of the boulder clay of the lower St. Lawrence has long been known, and doubtless the future will see an increase in the number of localities where this can be seen.

A depression of the land surface would cause a decrease of the ice-gathering area and would remove one of the causes of ice-formation. If this depression, then, were followed by removal of the ice-sheets, isostatic readjustment would again take place, and the land area would again be elevated. A record of such elevation exists in the successive beaches of the Saxicava sand, which indicate that this elevation, though gradual, was marked by definite pauses, with periods of permanancy of level sufficiently long to allow of the formation of definite beaches, and these pauses were more marked in the later stages of the elevation than in the earlier. This is shown by the fact that the higher beaches are continuous, whilst the lower ones are more sharply marked off from each other. With the gradual elevation, the arm of the sea in which the Leda clay was laid down[2] was gradually narrowed and shallowed, until finally the waters of the St. Lawrence in the district under consideration, became

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[1] Chamberlin and Salisbury. Geology, 1906. Vol. 3, pp. 356 et. seq.
[2] Chamberlin and Salisbury. Geology, 1906. Vol. 3, p. 404, fig. 522.

fresh. We have no definite information as to the exact level at which the St. Lawrence became fresh in the Montreal district, but it appears probable that it was fresh at a time when it was flowing at a level which is to-day represented by the 100-foot contour.

With the return of the St. Lawrence to its former proportions, though now flowing over a bed modified by the Pleistocene deposits, the recent system of surface drainage was set up. This is not of any considerable proportions on the Island of Montreal, consisting of a few inconspicuous streams which have cut their beds into the boulder clay, Leda clay, or Saxicava sand. Details of this drainage system were several small fresh-water lakes, which have been drained since the country was occupied by man, i.e., within historic times, indeed, almost within human memory. On the floors of these lakes have been deposited shell marl, composed of the hard parts of fresh-water gasteropods, and peat, with stratified lake clays, in some cases.

The different members of the Pleistocene and Recent succession will be described in detail below, with especial reference to their mode of occurrence and modifications, sections being given to illustrate the typical, and some of the more interesting of the non-typical, developments.

TOPOGRAPHY.

The effect of the activity of the Pleistocene period has been to almost completely obliterate former topographical irregularities, leaving only minor, rounded elevations instead of higher hills of more varied form. The interspaces between the elevations have been filled in by the deposits of the Pleistocene, and so the tendency to eradication of topographical irregularity furthered still more. The Island of Montreal is characterized by an almost flat surface, due to the Pleistocene deposits. Outside of Mount Royal, the most interesting topographical features are the two outliers of Leda clay capped by Saxicava sand at the western end of the island, which have been carved out of the more continuous deposits of those materials in the Recent period. The sea-cut cliffs accompanying the raised beaches will be discussed later. The cliff which runs generally parallel to the Grand Trunk railway, from about Point Claire into and beyond the City of Montreal, where it has been somewhat modified by man's activities, is regarded as a cliff carved out by the St. Lawrence.

Mount Royal itself owes its protuberance above its surroundings to the fact that the rocks (essexite and nepheline syenite), composing it are harder and more resistant than the limestone intruded by them. When the "Mountain" is viewed from the southeast it shows a steep slope toward the northeast and a more gentle one toward the southwest (See Frontispiece). This is the topographic form known as "crag-and-tail." It is held to be produced by glacial action, but as the ice came from the northeast, i.e., up the St. Lawrence valley, the steeper slope is on the side pointing toward the direction from which the ice came. This is just the opposite of the usual result, where the steeper slope is on the lee side (roches moutonée). The explanation of the formation of this crag-and-tail type of topography has not been satisfactorily given. It is a form shown by other members of the Monteregian hills. LeRoy has suggested, as a possible explanation, that it may be due to an original form of the igneous intrusions as sheets dipping slightly to the southwest, and that the form is that of the outcrop of such a sheet superficially modified by glacial erosion.[1] Such information as one possess concerning the form of the intrusions indicates that this explanation is not valid. Rounded and partially smoothed surfaces characteristic of glacial action are to be found at many points on Mount Royal. Striations, however, are not often to be found. On the softer limestone rocks, however, striations and often deep groovings, are abundant.

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[1]Geology of St. Bruno mountain, G.S.C. Memoir 7, p. 9.

CHAPTER II.

PLEISTOCENE AND RECENT DEPOSITS.

BOULDER CLAY.

CHARACTERS.

The boulder clay is typically a mixture of rock fragments, in which the size of the fragments may vary from that of a house down to the finest rock flour. The larger fragments are usually partially rounded, often with nearly flat surfaces indicating continued abrasion in definite directions at different times, and often marked by "striæ" produced during such abrasion. These are the so-called sub-angular boulders which are characteristic of glacial action, and are embedded in a very fine-grained, stiff clay, which is made up of the finer fragments, without any regular arrangement or distribution. The deposit thus formed is very characteristic, and is also sometimes referred to as "till."

The boulders within the boulder clay and also a large part of the matrix at any point, are for the most part derived from the immediately underlying rock. Thus within the City of Montreal a large percentage of the boulders are of Trenton limestone; at the new dry dock many boulders of Utica shale are present; and at the southwestern end of the island boulders of Beekmantown (Calciferous) dolomite are predominant. In addition there are many boulders which have been brought from a considerable distance, in some cases 50 miles, or even more. Conspicuous amongst these are the various boulders of gneiss, granite, quartz, anorthosite, etc., which have been brought from the Laurentian area to the north, or northeast.

The colour of the matrix of the boulder clay, when fresh, is usually dark bluish-grey, though where the Calciferous dolomite has helped to furnish the matrix, it may be dark brown. The bluish-grey boulder clay may be seen at the surface, but more usually a few feet of the matrix next to the surface are oxidized to a yellow or light brown colour. Sometimes the lower limit of oxidation is approximately parallel to the surface, sometimes it is irregular. The quicksand variety exposed at the filtration plant (see below), showed a very complicated boundary between the yellowish-brown oxidized and the bluish-grey unoxidized parts. A diagrammatic reproduction of this is shown in Figure 1.

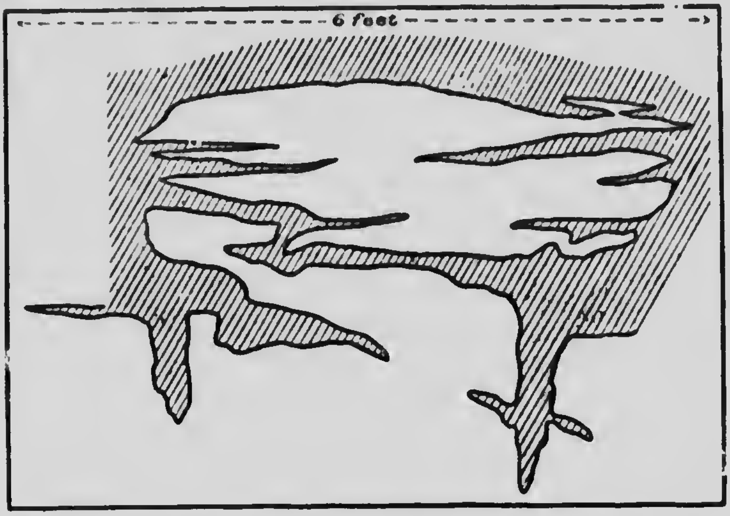

Figure 1. Diagrammatic vertical section showing weathering patterns in quicksand at filtration plant, Verdun. Shaded parts oxidized, unshaded parts blue-grey unoxidized quicksand.

DISTRIBUTION.

The boulder clay covers nearly the whole of the island, though, in some places, it is overlain by the younger members of the Pleistocene. With the exception of the Palæozoic outcrops in and around Mount Royal, the boulder clay covers the rocky ridge which runs down the centre of the island. The covering in the northern part of the island is usually thin, and has been removed around the rocky nose which runs almost parallel to the outline of the island from Longue Pointe toward the north, and from the Reparation chapel near Bout de l'Isle, to Bas au Sault, so that an almost continuous band of Trenton limestone is exposed. South and west of Mount Royal, the boulder clay runs to the Rivière-des-Prairies and to Ste. Anne-de-Bellevue, covering the whole surface of the island with a few exceptions to be mentioned below (under Leda clay, etc.), and excepting the Palæozoic outcrops at Bordeaux, Cartierville, Saraguayville, near Ste. Geneviève, Point Claire, and at several points between Beaconsfield and Ste. Anne-de-Bellevue.

The upper surface of the boulder clay is very uneven. The exposed surface is one produced by erosion and so is of fairly uniform nature, but the surface of the boulder clay on which the Leda clay was deposited, was very uneven. This is very well indicated by the outcrops immediately north of Strathmore. Again, at Lakeside, at the Terra Cotta Lumber Company's plant the railway runs upon boulder clay, whilst at the plant itself, Leda clay is found to a depth of 26 feet below the surface. These inequalities of the surface of the boulder clay are probably attributable both to original inequality of deposition and to subsequent erosion, but most of it to the former cause.

VARIATIONS.

By the gradual reduction of the size and number of the boulders, the boulder clay may pass into a variety which has the appearance of an unstratified Leda clay. When such a clay is exposed in an excavation it is difficult to interpret it properly, unless there are other varieties exposed along with it. Thus in many of the excavations in Westmount it is difficult to determine whether the clay exposed is Leda clay or boulder clay. When such a boulderless variety is merely exposed on the surface its simulation of Leda clay is even more strong and it is often a matter of the utmost difficulty to place a geological boundary on that account.

Again, by the suppression of the boulders and of the clayey part of the matrix a variety is produced, composed almost entirely of fine grains of quartz, together with a small quantity of clay. This may be called a quicksand, because it has the property of running or flowing when it contains a certain percentage of water. Excavations made in such quicksands often fill up over night, in spite of careful timbering, by reason of the flow of the wet quicksand into the hollow formed by the excavation, in part below the ends of the timbers, and in part between the very small cracks between the timbers.

Such a quicksand was met with in the excavation made in connexion with the City of Montreal's filtration plant, in course of construction in 1913. An examination of this material was made by Messrs. Milton Hersey Co. Ltd., from whose report the following information is taken, with their permission:

	1.	2.
SiO_2	57·40	58·85
Al_2O_3	17·50	13·25
Fe_2O_3	7·00	6·25
CaO	1·84	7·00
MgO	3·11	2·61
SO_3	4·95	2·47
K_2O	1·82	3·60
Na_2O		7·67
Ign	8·05	7·67
	101·67	101·70

Analyses 1. Soil from new city filter.

" 2. Boulder clay from northwest corner of Peel and St. Catherine streets.

N.B. FeO calculated as Fe_2O_3. S. calculated as SO_3.

(It is considered that the close correspondence of these analyses in certain particulars is not of very great importance.)

Another analysis of a sample from the filtration plant showed 65 per cent of SiO_2.

"An examination and comparison of the material from the filtration plant and the boulder clay showed that of the former 79·63% passed through a 200-mesh sieve, (but of that which did not pass through, 7·6% consisted of coarse sand and pebbles), whilst of the matrix of the latter 86·17% passed through a 200-mesh sieve. Flotation tests were carried on which showed that this sand and the boulder clay consisted of particles of similar sizes, and in similar amounts, but that they were both very

2

different in these respects from Leda clay. Microscopic examination showed that both consisted of *angular* crystalline fragments."

The writer has made an examination of the microscopical preparations of the Messrs. Milton Hersey Co. Ltd., and found that nearly all of the angular crystalline fragments are quartz. In addition there are present a few fragments of green hornblende, garnet, etc. The grains are sharply angular, and it is this character which decides definitely that the grains have been produced by crushing or breaking, and, therefore, by glacial agency.

At the time when the writer visited the locality a section of 8 feet was exposed, which showed:

2 ft. yellow oxidized sandy clay.
5 ft. bluish sandy clay.
2 ft. boulder clay.

The boulder clay passed without apparent break into the bluish sandy clay. The upper 7 feet of the section contained only occasional small smoothed boulders, so that a division by means of the presence and absence of boulders could be made between the lower 2 feet and the rest of the section, but there was no actual depositional break. The yellow oxidized part is merely the weathered upper surface of the bluish clay. It is here that the fantastic weathering patterns were observed (See Figure 1) The bluish sandy clay was dry at the time of examination and had sufficient cohesion to stand unsupported on the walls of the excavation, and an external examination of it gave no inkling of the fact that when mixed with water this same material would run almost like a liquid. This material, which can be called nothing but boulder clay matrix, is a veritable quicksand, according to the above definition, i.e., no matter what its properties when dry, when mixed with a certain percentage of water it will flow. Investigation to determine what this percentage of water is, has not been carried out.

As to the conditions under which such a deposit was formed no definite statement can be made, other than that the rock is composed of angular crystal grains formed by grinding or crushing, i.e., by glacial agency, and whether directly deposited by the glacier or by a stream issuing from a glacier, or whether deposited from suspension in the sea, cannot be determined.

An excavation being made for a railway switch at the Montreal Light, Heat, and Power Company's new plant on the southeast side of the Lachine canal showed very interesting relations. A section of 15 feet on the face of the cliff toward the Lachine canal showed:

10 ft. gravel (See p. 33).
5 ft. bluish-grey quicksand.

The upper part of the quicksand was oxidized to a brown colour, the line of demarcation between the two colours being diagrammatically shown in Figure 10, page 42. The quicksand, when traced to the southeast, was seen to pass into boulder clay by a gradual loss of the sand and increase in number of boulders. No line of demarcation could be made, and the quicksand must be regarded as a phase of the boulder clay. The quicksand was nearly dry at the time when it was seen, but even so, when a horse walked over it, the surface could be seen to vibrate for a distance of 10 feet around the horse.

At the new Customs house on McGill street, opposite the end of Wellington street, quicksand caused considerable trouble. First attempts to construct a foundation by ordinary open excavations were unsuccessful by reason of the continual influx of quicksand, which, over night, filled or partially filled up the excavations as made, and at the same time placed in jeopardy the safety of the surrounding buildings. Consequently another method had to be introduced and caissons were sunk under compressed air to bed-rock, and even so, it was necessary to work continually and to concrete the foundation immediately bed-rock was reached. The distribution of the drift over the area worked varied considerably. A partial section showed:

6–25 ft. dark brown to black quicksand at surface.
6–8 ft. boulder clay.
1 ft. gravel.
28–12 ft. boulder clay.
4–1 ft. sand and gravel.
Bed-rock at a maximum depth of 74 feet (Utica shale).

The writer was unable to examine this section personally. It is possible that part of the section consists of river gravel and its modifications.

An excavation for a trunk sewer a few hundred yards east of Montreal Junction station showed quicksand within the boulder clay. The sewer runs approximately at right angles to the Canadian Pacific railway and Upper Lachine road at this point, and so runs down the steep bank which overlooks the Grand Trunk railway and the Lachine canal. At the time the excavation was examined, only the part between the Canadian Pacific railway and the Upper Lachine road was exposed. South of the Upper Lachine road, the cut showed:

2½ ft. stratified, grey Leda clay. (Seen at the sides of the filled-in cut.)

? yellow sand.

? boulder clay. (Inferred from dump.)

North of the Upper Lachine road, halfway between the road and the Canadian Pacific Railway track, the section showed:

2 ft. yellowish boulder clay with many small boulders.

16 ft. bluish boulder clay.

6 ft. yellowish sand.

6 ft. dark blue-grey quicksand.

Nearer the road the sand reaches nearer the surface, the cover of boulder clay being thinner.

At a point 160 feet west of Guy street on Sherbrooke street an excavation to a depth of 35 feet showed:

1 ft. macadam.

3 ft. boulder clay.

32 ft. Trenton limestone.

Farther west, at the head of St. Mark street, a 12-foot section showed:

6 ft. brown oxidized boulder clay.

1½ ft. blue unoxidized boulder clay.

4½ ft. bluish-grey quicksand.

The sections given above illustrate the fact that the boulder clay is by no means constant in its characters. The sections have been selected to bring out this point, and are to be regarded as showing abnormal rather than normal development of the boulder clay. They serve to show that the boulder clay, in some places, passes laterally into a quicksand, and that this quicksand is a true member of the boulder clay is shown by those sections in which the boulder clay is found above the quicksand.

The thickness of the boulder clay naturally depends upon the irregularities of the rock surface below, and so it varies within wide limits. No satisfactory guide can be given with regard to estimations of thickness. Figures of thickness obtained even on the next lot cannot be used to indicate the thickness at any point. It is only to be found by actual trial, by boring, or otherwise.

For further details regarding boulder clay modifications see description of section at the school on Melville street, Westmount, on pages 36 and 41.

LEDA CLAY.

CHARACTERS.

Typically the Leda clay is a grey or bluish-grey clay, and may show stratification or lamination, which is sometimes exceedingly fine, or may show no stratification at all. It contains, very rarely, boulders of varying sizes, but usually very small ones. Upon weathering it breaks in joint blocks. It contains marine fossils (for list of fossils see p. 65), and hence is a deposit which was laid down on the floor of the sea. The establishment of an arm of the sea extending up the St. Lawrence, Ottawa, and Champlain valleys, the sea of the so-called "Champlain substage" of the Pleistocene, has been discussed above. With the establishment of this sea the period of continental glaciation appears to have ceased, or to have been rapidly waning. The action of the agents of denudation on the deposits left by the ice-sheet removed the finer material from the boulder clay exposed, in some cases leaving the boulders stranded and free upon the surface. The material of the matrix was washed down by the streams and carried out into the Champlain bight, the coarser material being there deposited along the shore-line as Saxicava sand, and the finer material being carried farther out from the shore in milky suspension, and gradually deposited upon the sea-floor to form the Leda clay, as we know it. The blue-grey colour of the Leda clay is due to the fact that the iron present is in the ferrous state of oxidation, attributed by Sir J. W. Dawson to reduction by organic material on the sea-floor. Occasional red layers, usually a few inches thick and not often more than 1½ feet thick, are present in the clay. Here the iron is in the ferric state of oxidation and this is explained by the absence of such organic reducing matter on the sea-floor.[1]

The Leda clay often contains layers of grey sand which serve to accentuate the stratification. Sometimes the layers of sand are only one grain thick. In the upper part of the Leda clay these layers of sand become numerous, and are there often rich in organic remains, the most conspicuous of which are shells of lamellibranchs. These are the layers which have furnished to Sir J. W. Dawson the greater part of the Leda clay fauna. A section, now no longer exposed, at Logan's farm (on the site of the present Lafontaine park), may be reproduced here, and may be regarded as a standard section illustrating the development of the shell-rich sandy layers of the upper part of the Leda clay.

1 foot 9 inches, soil and sand.

½ inch, tough reddish clay.

8 inches, grey sand, a few specimens of *Saxicava rugosa*, *Mytilus edulis*, *Tellina greenlandica*, and *Mya arenaria*, the valves generally united.

1 foot 1 inch, tough reddish clay, a few shells of *Astarte laurentiana* and *Leda glacialis*.

8 inches, grey sand, containing detached valves of *S. rugosa*, *M. truncata*, and *T. greenlandica*: also *Trichotropis borealis*, and *Balanus crenatus*, the shells in three thin layers.

1 foot 3 inches, sand and clay, with a few shells, principally of Saxicava in detached valves.

3 inches, band of sandy clay, full of *Natica clausa*, *Trichotropis borealis*, *Fusus tornatus*, *Buccinum glaciale*, *Astarte laurentiana*, *Balanus crenatus*, etc., sponges and Fora-

[1]Canadian Ice Age, p. 54.

minifera. Nearly all the rare and deep-sea shells of this locality occur in this band.

2 feet 0 inches, sand and clay, a few shells of Astarte and Saxicava, and remains of sea-weeds with Lepralia attached: also Foraminifera.

Depth unknown. Stony clay. (Boulder clay.)[1]

Sir J. W. Dawson divided the Leda clay into a lower and an upper part, the lower part unfossiliferous, or with shells only of *Leda glacialis* and *Macoma greenlandica*, and the upper sandy part carrying a rich boreal fauna. It is this upper sandy part that is illustrated in the section given above. It is the lower part which is used on the Island of Montreal for the manufacture of structural materials.

DISTRIBUTION.

The Leda clay underlies the flat which extends around the rocky ridge of the northern part of the island, from Bas au Sault to Bout de l'Isle, and from there to the locomotive works in Maisonneuve. From this point west, the exact distribution is not yet known by reason of the absence of the requisite excavations, but the Leda clay forms the cliff which is capped by Saxicava sand, running from Maisonneuve along the north side of Ontario street as far west as Guy street; but west of Peel street, the Leda clay does not run as far north as Sherbrooke street. The northern boundary of the area underlain by Leda clay within the city runs approximately from the corner of Peel and Sherbrooke streets to the southern edge of the Mile End quarries, as now being worked, the northern side of the Angus shops, and north of Rosemount boulevard in Maisonneuve. A certain part of Westmount, around Westmount station, and of Montreal around the Glen, is underlain by Leda clay, but this area is not yet definitely marked off. The great similarity in characters between some varieties of boulder clay and Leda clay has been mentioned above, and it makes it necessary to merely record and describe certain of the exposures. The Westmount area of the Leda clay is continued west along both sides of the Upper Lachine road and ends a little to the west of the Town Hall of Montreal West.

[1] Canadian Ice Age, p. 196.

On the west side of the "Mountain" there is, to the west of the Canadian Pacific railway, an area covered by Saxicava sand and underlain by Leda clay. An exposure was made in it by the cutting of the Canadian Northern railway. The exact area so underlain is not yet delineated.

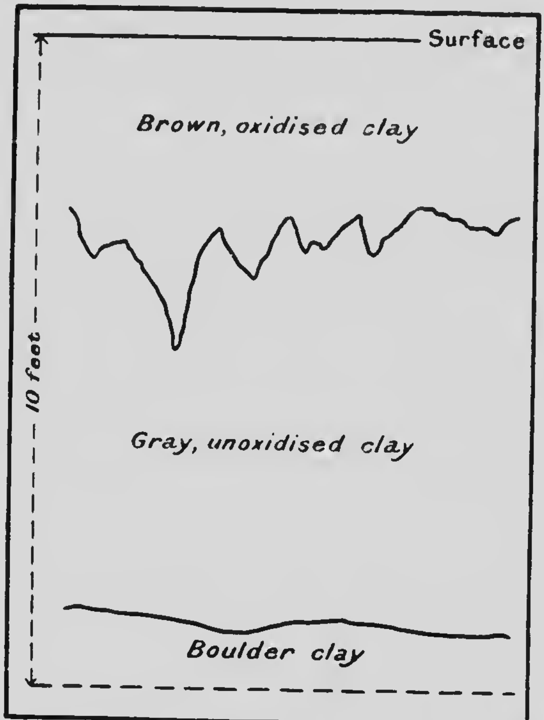

Figure 2. Diagrammatic vertical section showing boundary between oxidized and unoxidized Leda clay, at crossing of Ernest and Charlemagne streets, Maisonneuve.

There is an area of Leda clay extending from a little north of Blue Bonnets race track almost to Montreal Junction, and having a maximum width of one mile.

Leda clay extends west from Dorval, through Lakeside, to beyond Beaconsfield station, the maximum width of the area, measured from the shore of Lake St. Louis, being 2½ miles.

From the St. Charles road, along the Ste. Marie road to the western tip of the island at Senneville, stretches an area of Leda clay, which is overlain in its more western part by Saxicava sand, the same being true of another small area south and east of Baie d'Urfe station. There are a few other small exposures of Leda clay along the bank of Rivière-des-Prairies, between Senneville and Ste. Geneviève, and some along the shore of Lake St. Louis near Pointe Claire.

The upper surface of the Leda clay is sometimes oxidized to a brown or yellow clay to a depth of a few feet from the surface, though this is by no means general. An example of the unevenness of the boundary between the oxidized and unoxidized clays is shown in Figure 2.

A few sections will serve to show the general features and relations of the Leda clay.

The Davidson Street section shows characters which are typical of the lower part of the Leda clay:

5 ft., yellow unfossiliferous sand (in part removed). Saxicava sand.

20 ft., grey clay, in part finely stratified. The stratification can only be seen on close inspection. The clay breaks off into joint blocks on weathering. Shells of *Leda glacialis* and *Macoma greenlandica* occasional, shells often united. Small rounded boulders rare.

At the northwest corner of Peel and St. Catherine streets, a 22-foot section showed:

12 ft., grey Leda clay, with a 3-inch red layer near the base.

9½ ft., yellowish, non-stratified loamy Leda clay.

6 inches, boulder clay.

Trenton limestone.

At the cut outside the west portal of the Canadian Northern Railway tunnel, at a point 200 yards west of the Canadian Pacific railway, the following section was exposed:

3½ ft., brown, stratified sand and gravel with many shells. (*Saxicava rugosa*, *Macoma greenlandica*, *Mya truncata*, and *Mytilus edulis*.)

13 ft., blue boulder clay, with small boulders. The upper 2 feet sandy.

Farther west the boulder clay is covered by a rich shell bank in which Saxicava and Macoma are most numerous. This part of the section was not well exposed. At one point was seen:

3 ft., yellowish sand without fossils.

3 ft., (?) reddish bands of Leda clay alternating with shell beds a few inches in thickness.

8 ft., bluish-grey boulder clay.

One-quarter of a mile west of the Canadian Pacific Railway track the cut showed:

5 ft., greyish sand rich in shells.

2½ ft., reddish-grey Leda clay.

1 ft., sandy grey Leda clay.

6 ft., bluish-grey boulder clay.

One mile west of the Canadian Pacific Railway track it showed:

4½ ft., yellowish Saxicava sand rich in shells of Saxicava and Macoma.

1 ft., grey Leda clay.

Rest of section covered by slipped material.

A few yards farther to the west was seen 1 foot of yellow sand overlying 5 feet of grey Leda clay, while a few yards farther only boulder clay is to be found beneath the thin capping of gravel.

At a point 418 yards north from the shore road at Pointe Claire on the road leading to the station, a section showed the Leda clay-boulder clay contact. The boulder clay was slightly

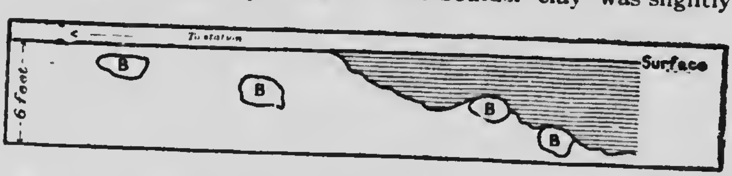

Figure 3. Diagrammatic vertical section showing contact of stratified Leda clay (shaded) with boulder clay (unshaded), near Pointe Claire. B = Large boulders. Length of section 50 feet.

yellowish and contained large boulders up to 3 feet in diameter, and the Leda clay was grey, with very fine stratification and occasional thin sandy partings. The contact is diagrammatically reproduced in Figure 3.

VARIATIONS.

In addition to the more normal varieties of the Leda clay mentioned above, there are some others which call for more special attention. These will be illustrated by particular sections.

A section at an elevation of about 175 feet above sea-level, exposed at the north end of King Edward avenue, where it abuts on the Côte St. Luc road, close to the stone church, showed a normal development of the Leda clay thus:

1 ft., soil.
7 ft., bluish Leda clay.
1 ft., reddish Leda clay.
5 ft., Leda clay, bluish passing into yellow below.

At a point 660 yards to the southwest of the latter point, and along the Côte St. Luc road, another section was exposed, the top of which was a few feet below the base of the section last given. Here was exposed:

3½ ft., yellow oxidized clay. (Leda clay.)
3½ ft., yellowish sand.
2 ft., dark bluish-grey quicksand. (A water-logged mixture of sand and clay which runs easily when trodden.)

The whole of this section is evidently representative of the Leda clay, the quicksand being merely a local variant of the normal clay.

At Delorimier avenue and Burnett street a section showed:

1 ft., yellow-brown clay with thin sandy partings (sometimes only one grain thick.)
1½ ft., dark blue quicksand.

Quicksand is said to have been encountered in the foundation of the extension of the building of the Montreal Light, Heat, and Power Company at the northwest corner of Craig and St. Urbain streets, but of this there is no definite information to hand and nothing to indicate into which section such a deposit would naturally fall.

The excavation for the foundation of the new post-office at the southwest corner of Bishop and St. Catherine streets exposed a very interesting section, as follows:

19·2 ft., bluish, non-stratified Leda clay.

1 ft., bluish-grey clay with small boulders, usually rounded.

13 ft., bluish-grey, sandy clay passing into quicksand below.

Boulder clay of bluish-grey colour, with large boulders.

The whole of the 33 feet above the boulder clay is regarded as representing the Leda clay. The 1 foot of clay with boulders is considered to be a record of the dropping of material from floating ice of the Champlain sea, and the quicksand and sandy clay beneath this layer represents the change from the continental glaciation to the Champlain conditions. Similar quicksands are known to occur at the base of the Leda clay in other parts of Canada. Where these rest on sloping rock surfaces, which are also glacially smoothed, or upon another layer of impervious clay, they present ideal conditions for the production of landslides. With the thaw of the springtime the quicksands become heavily charged with water, and so, in some exceptional seasons these quicksands flow away from beneath the Leda clay overlying them, and if the clay is exposed upon one side, e.g., in a river bank, there ensues a precipitation of a part of the bank into the valley below. Such landslides have been common in the lower St. Lawrence valley, and a famous one occurred at Notre Dame de la Salette, on the Lièvre river in the spring of 1908. These landslides often occur with remarkable suddenness, giving no signs in advance, and sometimes, as in the case of the Salette slide, they are accompanied by loss of life.[1]

The sections at the Glen are particularly interesting and confusing. Where the Glen road runs under the Canadian Pacific Railway track there is a cliff of about 30 feet in height on each side of the road. The face on the west side of the road shows:

1 ft., soil.

2 ft., brownish Leda clay extending only a short distance to the south; see Figure 4.

3½ ft., yellow sand, also with small southern extension.

12 ft., stratified gravel.

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[1] Report on the Landslide at Notre Dame de la Salette, Lièvre river, Que. R. W. Ells, G. S. C. No. 1030.

A few small boulders occur in the lower layers of the Leda clay, and also in the sand. The gravel contains many boulders or pebbles, up to 1 foot in diameter, many of the larger of which are sub-angular, whilst the smaller ones are rounded a' obviously water-worn. The gravel is well stratified, but the lines of stratification are curved, as shown in the figure, dipping toward the north, i.e., toward the Canadian Pacific railway.

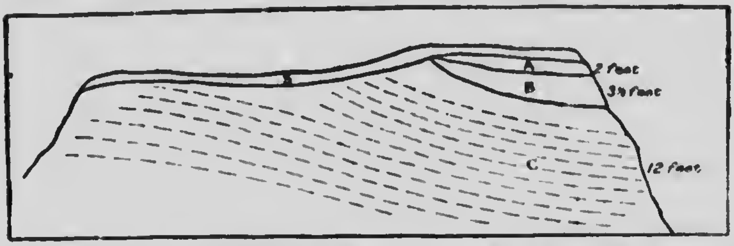

Figure 4. Diagrammatic vertical section on west side of Glen road, immediately south of Canadian Pacific railway. S = sod and soil; A = brown clay, B = yellow sand; C = stratified gravel.

A little south of the last point discussed, the front of the cliff, as it faces toward the Lachine canal, can be seen. It shows:

1 ft., soil.
4 ft., drab-coloured Leda clay.
½ ft., red Leda clay.
2 to 3 ft., drab-coloured Leda clay.
12 ft., yellow sand, without fossils.

The base of the cliff is concealed by talus.

On the opposite, i.e., the east side of the road, the exposed front of the cliff shows:

4 ft., grey Leda clay.
½ ft., reddish Leda clay.
1½ ft., grey Leda clay.
25 ft., yellow sand.
5 ft., sandy clay with boulders.

From this it would appear that the gravels exposed nearer to the Canadian Pacific railway are replaced by the yellow sands exposed on the face of the scarp. A continuous section showing the passage from the one to the other was not obtainable, nor was it possible to get the full thickness of the gravel shown by the first of the Glen sections given above.

Sir J. W. Dawson gives, on page 202 of his Canadian Ice Age, a 57-foot section at the Glen brick works which is here reproduced:

7 ft., hard grey, laminated clay, Foraminifera and Leda, in thin layers.
½ ft., red layer, in two bands.
1 ft., sandy clay.
9 ft., grey and reddish clay.
15 ft., hard buff sand, very fine and laminated.
4 ft., sand with layers of tough clay, holding glaciated stones, and very irregularly disposed.
1 ft., fine sand.
4 ft., grey sand, with rounded pebbles, and laminated obscurely and diagonally.
3 ft., fine, laminated yellow sand.
4 inches gravel.
12 ft., very irregular mass of laminated sand, with mud, gravel, stones, and large boulders.

The deposits are evidently of a littoral character, as pointed out by Dawson. He held them to be the shore representative of the deposits of the Champlain sea, formed as the deepening sea brought the shore-line to this point. He referred them to the later part of the boulder clay, but according to our conception of the history of the Pleistocene, they would be included in the Leda clay, as its basal representative. However, the absence of fossils in the sands and gravels is to be noted, though this is not considered to be an important matter.

Another possible explanation of the occurrence is that the sands and gravels are really kame-like, having been deposited against a temporarily stationary ice-front, which later retreated, the Leda clay being almost immediately deposited upon the sands and gravels as they were carried under water, by depression of the land surface. In connexion with this idea see section at the Melville Avenue school, Westmount (pages 36 and 41).

A 10-foot excavation on the southwest side of Glenranald avenue showed, in the upper part, grey, stratified Leda clay of normal character, and carrying shells. The lower part of the section showed a clay rich in boulders and shells, and occasionally stratified. The presence of the shells and of the occasional stratification are considered to be criteria necessitating the inclusion of this modification with the Leda clay. It must be regarded as one of those occurrences which bridge over the gap between the boulder clay and Leda clay, a gap which is often so clearly and sharply marked (See Figure 3).

SAXICAVA SAND AND GRAVELS, AND SHORE-ICE DEPOSITS.

CHARACTERS.

Under the heading of Saxicava sand and gravel are included all those beach deposits, consisting of yellow iron-stained sand, or of coarser, yellow or brown sand with larger rounded pebbles (sometimes up to 1 foot in diameter), and usually carrying shells in greater or less abundance, which occur on the flanks of, or lower slopes surrounding, Mount Royal. The "Mountain," like other members of the Monteregian hills, was a "gigantic tide-gauge" upon which the successive stages of the recession of the Champlain sea were recorded as more or less distinct beach levels. The higher beaches are usually of coarse gravel whilst the lower ones are sandy, and pebbles are only occasional in them. Stratification and cross-bedding are often to be seen in the sands, and gravels. The most common shell in them is *Saxicava rugosa*, and of the others, those which occur with the greatest frequency are *Macoma greenlandica*, *Mya truncata*, and *Mytilus edulis*.

The Saxicava sands and gravels rest unconformably on the rocks below, which may be Palæozoic, boulder clay, or Leda clay, e.g., the beaches exposed in the Mile End quarries, at present, rest in some places upon boulder clay, and in others directly upon the Trenton limestone. The relations of one of the higher terraces as exposed in a 7-foot deep excavation from Decelles avenue, along Brunet avenue in Côte-des-Neiges village, as far as its contact with the essexite are shown in Figure 5. The boulder clay, at first 6 feet thick at Decelles avenue, is overlain by 1 foot of gravel. The boulder clay surface is irregular, and toward the essexite the whole 7 feet of the excavation is occupied by gravel, which finally rests abruptly against the steeply sloping edge of the essexite.

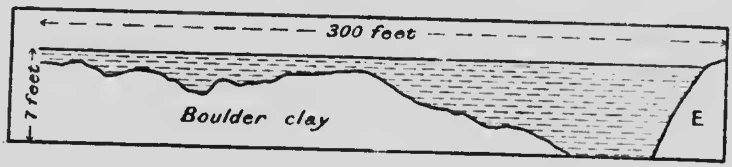

Figure 5. Diagrammatic vertical section showing stratified gravel unconformable upon boulder clay (unshaded) and essexite [E] at Brunet avenue, Côte-des-Neiges.

Again, the Saxicava sand of the Sherbrooke Street terrace rests upon the Leda clay with a disconformable relation. It is to be supposed that, whilst the higher terraces of the "Mountain" were being formed, Leda clay was still being formed offshore. As the land surface rose relatively to sea-level, the waves of the St. Lawrence gulf would cut into this Leda clay and form a series of cliffs, corresponding to the periods of halting in the elevation, just as we see the cliffs being cut back on the lower reaches of the St. Lawrence to-day. It is one of these wave-cut cliffs which is so well marked all through the eastern part of the City of Montreal in passing up from the Ontario Street to the Sherbrooke Street level. The sand which rests on the clay at the Sherbrooke Street level also rests on a flat level which was carved out in the same way. The upper part of the Leda clay has been removed, so that the contact between the Leda clay and Saxicava sand, though conformable, represents a lapse of time during which a certain amount of previously deposited material was eroded. This is best illustrated by the exposure at the brick-yard on Davidson street.

Other examples of the relations of the Saxicava sand and the underlying strata are given above (see West Portal sections, page 17), and below, see Loyola College sections (page 37 et seq.)

A section at the southwest corner of the Hampton Avenue-Sherbrooke Street crossing, in Notre Dame de Grace, illustrates the variability of the Saxicava sand deposits:—

½ ft., gravel.
1 ft., sand.
1½ ft., sandy gravel with shell fragments.
3 ft., sand.

The sand and gravel are all cross-bedded, and the sands, especially, are very pockety in their distribution, so that the lower layer of gravel in places rested directly on the boulder clay beneath.

Only occasionally is the Saxicava sand of a grey unoxidized colour. This was noticed on Metcalfe street 150 feet north of Burnside, where the lower part of the sand was peaty, and on the south side of St. Catherine street between Bishop and Guy streets.

Naturally, much of the material of the Saxicava sand, and more especially of the gravels, is derived from the boulder clay. And, in some places the surface material is boulder clay, which shows practically no evidence of having been reworked. Where sections are not available these occurrences are apt to be misleading. Careful search over the surface will be repaid, however, by the discovery of very occasional fragments of Saxicava, or the other common shells. This state of affairs is seen more especially on the west flank of the "Mountain" beyond Côte-des-Neiges village, and round toward Outremont.

At the southwest corner of St. Denis - St. Catherine streets, a 16 foot excavation made for the foundation of the Dandurand building showed:

8½ ft., yellow Saxicava sand.
2-3½ ft., bluish-grey quicksand. (Mixture of sand and clay.)
4 ft., bluish-grey boulder clay.

The quicksand was cut out toward the west by a bed of gravel, as shown in the accompanying figure (Figure 6). There were no fossils present. Whether the quicksand and gravel are to be regarded as representatives of the Leda clay or of the Saxicava sand is not clear, but probably they represent the latter. The contact of the quicksand with the boulder clay is quite distinct and sharply marked.

Above the Saxicava gravels of the higher beaches there is to be seen at one or two points a deposit resembling boulder clay, in that it contains angular, and sometimes sub-angular boulders of varying sizes, without any definite arrangement, in a matrix of loosely compacted, dark brown, earthy clay.

Sir Charles Lyell described such an occurrence in his 'Travels in North America,' there given as occurring above Côte-des-Neiges village, and more than 500 feet above sea-level.

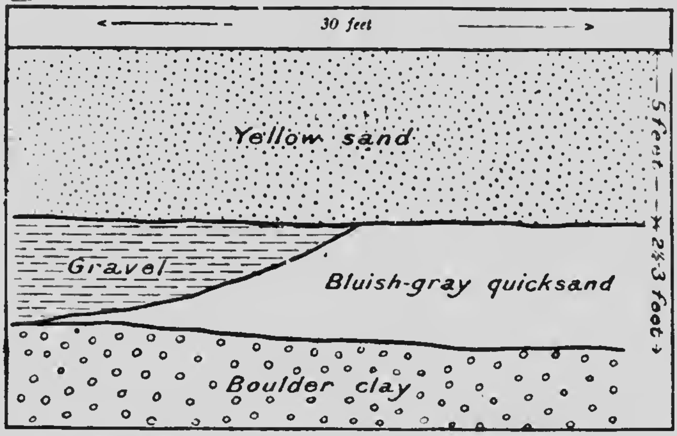

Figure 6. Vertical section showing relations of gravel, quicksand, and boulder clay at the Dandurand building, corner of St. Denis and St. Catherine streets.

Between the autumn of 1912 and 1913 there has been exposed a similar section on Côte-des-Neiges road, immediately opposite the end of Westmount boulevard. Here boulder clay is overlain by gravel with curved stratification and often rich in Saxicava. The gravel is pockety, its lower surface being irregular, and the stratification, in part, following these irregularities. Two or 3 feet of these gravels were seen, and above this, the deposit resembling boulder clay described above, to a maximum thickness of 6 feet. There is no evidence that this material is made ground, so the following explanations suggest themselves:

(1.) That the material is true boulder clay and the gravel is interglacial, as supposed by Lyell.

(2.) That it is a deposit of drift-ice along shore.

(3.) That it represents talus and wash swept down from the slope to the north.

(4.) That the gravel was accumulated at the edge of a small cliff of boulder clay, which collapsed later and covered the gravel.

The three latter explanations would each of them appear to be worthy of consideration, whilst the first one should be regarded with distrust.

An examination of some of the higher beaches in Mount Royal park, notably those finger-like spits shown on the map illustrating Excursion A10 of the Twelfth International Geological Congress, showed that shells were to be found round the bases of the ridges, but that the ridges themselves were composed of earthy material, which from an examination of the surface appears to be very similar to that exposed above the gravel on Côte-des-Neiges road (vide supra). If this be taken as correct, and it is expected that a section through these ridges would reveal similar deposits, then suggested explanation No. 2 becomes the most probable. It is this one which is adopted here, and hence the deposits here under discussion are treated as deposits formed practically contemporaneously with the Saxicava gravels, and either shoved up on top of the gravel by the grounding of shore-ice, or floated up by the tides and deposited by the melting of the stranded slabs of ice carrying the dirt and boulders.

These are the deposits called upper boulder clay by Sir J. W. Dawson, but it has been considered better to drop the term boulder clay when referring to them, because of their negligible distribution, compared with the boulder clay as treated in this report, and also because of the implied mode of origin that the term boulder clay is taken to connote, at the present day.

DISTRIBUTION.

There are two exposures of unfossiliferous Saxicava sand capping outliers of Leda clay, one of them to the southeast of Baie d'Urfe station, and the other extending from the St. Marie road almost to the edge of the island at Fort Senneville. With these exceptions the Saxicava sands and gravels of the island are confined within an area roughly described by the following limits: Montreal West, Villeray, Maisonneuve, and Dorchester street.

For the most part the beach gravels are not distinctly separate from each other, but occur as continuous blankets, upon the surface of which occasional flats indicate halts in the recession of the sea-level. Thus from the highest point at which gravels are found in the Roman Catholic cemetery (617 feet above sea-level), there is a continuous gravel deposit extending almost to the chapels in the lower part of the cemetery. Below, there is another blanket which can be followed as a continuous deposit through Côte-des-Neiges village into Outremont, round the back of Westmount up to the highest beach level yet recorded on Westmount, and out to Montreal West. The gradual slope, with periodic levels, can be very well seen by passing from the head of Lansdowne skew on Westmount, and through Notre Dame de Grace to Montreal West. Within Mount Royal park and the Protestant cemetery and on Côte-des-Neiges road near the end of Westmount boulevard, the beaches there developed are small isolated patches; but the beach which is most distinctly and sharply marked off from the rest as a single beach formation, is that of the Sherbrooke Street level. This extends from the head of Peel street out to beyond Avenue Pie IX in Maisonneuve, broken only where the sand has been removed by man, and at no point is it joined on to any of the higher beaches. Below the level of Sherbrooke street there is a sand about the level of Dorchester street, and St. Catherine street, but, whether this is a marine sand or not, is not clear.

The thickness of the Saxicava sands and gravels naturally is a very variable quantity. Often it is only a few feet; but it must be at least 20 feet, and perhaps more, on the western slopes, at about 125 feet above sea-level, of Westmount (one exposure shows 16 feet). The thickness in the Roman Catholic cemetery runs up to 30 feet according to one of the gravediggers, this having been determined by well-driving.

BEACH LEVELS.

Some forty-six determinations of beach levels have been made in different parts of the city and island, a list of which is appended. These indicate that beach formation has taken place at 28 distinct altitudes, and of these 27 may be said to represent important general levels, so far as the Island of Montreal is concerned. How far these levels can be applied to other localities remains to be seen.

The discovery of a new upper limit of submergence on Mount Royal is a matter of considerable scientific interest and importance, as it bears directly upon the determination of the amount of warping, or inequality of uplift, which the region of the lower St. Lawrence has undergone in geologically recent times. The accepted highest beach of Goldthwait is given by him as 568 feet above sea-level. The highest beach of de Geer (625-615 feet barometer elevation), appears not to have been accepted as such by Goldthwait. Critical examinations and re-examinations of this beach have been made by the writer, and have led him to accept this as a true beach, though lacking some of the more obvious features of such deposits. Thus shells and stratification have not been observed; but the pebbles show the effect of wave action in their well-rounded shapes. The highest point of this beach, as now determined, is 585 feet above sea-level. The subsequent discovery of shell-bearing gravel running up to an even greater altitude in the Roman Catholic cemetery (617 feet), confirms this acceptance of de Geer's beach.

In the list of beach elevations given below each determination is given a number, beginning at the highest, and also a name usually referring to the locality at which the determination was made. In this way reference will be made easy and definite. Some of the beaches have been grouped together, representing general levels, and where some other levels appear to be sufficiently near one group to be included within it, but have been associated with other groups, it may be taken that there is a field reason for this connexion, for example one of the lower members of a group may be a lower point along one of the ridges in the same group, giving a higher figure. It is to be noted that corresponding beaches are often to be found in different parts of the city, and on different sides of the "Mountain," whilst, at the same time, many elevations at which beach formation has taken place on one side of the "Mountain" are not marked by any level flat on the sloping gravel on the other side.

			Feet.
Above 600 ft.	1.	Highest Roman Catholic cemetery	617
Above 500 ft.	2.	de Geer's beach	585
	3.	Park Ranger's house. (Goldthwait 568 feet)	574
	4.	Highest south of Park slide	566
	5.	Middle finger beach, south of Park slide	553
	6.	Upper Protestant cemetery (Goldthwait 564 feet)	544
Above 400 ft.	7.	Westmount, highest	494
	8.	Lower Protestant cemetery	482
	9.	Middle Roman Catholic cemetery	478
	10.	Landsdowne skew	471
	11.	Côte-des-Neiges (Lyell's ?)	467
	12.	Victoria avenue	427
	13.	Lower Roman Catholic cemetery	418
	14.	Ski club	403
Above 300 ft.	15.	Upper Piedmont avenue	386
	16.	Maplewood avenue	381
	17.	Lower Piedmont avenue	378
	18.	Dunlop avenue	333
	19.	Above Decarie's melon patch	330
	20.	Outremont pebble beach	310
	21.	Marlowe avenue	309
	22.	St. Catherine road (approximate)	303
Above 200 ft.	23.	Queen Mary road	275
	24.	Notre Dame de Grace	256
	25.	Bloomfield avenue	254
	26.	Davaar avenue	252
	27.	Decarie boulevard	249
	28.	Snowdon Junction	232
	29.	Defleuromont	228
	30.	Outremont, C. P. R.	222
	31.	Côte St. Louis road	218
	32.	Madison avenue	216
	33.	Hampton avenue	211

			Feet.
	34.	Papineau	207
	35.	Mile End, C. P. R.	206
	36.	Marcil avenue	204
Above 100 ft.	37	Villeray	193
	38.	Park Avenue extension	191
	39.	Rosemount (Pie IX)	179
	40.	Baie d'Urfe	169 and 163
	41.	St. Famille	153
	42.	St. Hubert (Duluth)	152
	43.	Pie IX—Sherbrooke	151
	44.	Delorimier park	150
	45.	St. Catherine-Metcalfe	125
	46.	St. Catherine-Bleury	119

Reference to the map accompanying this report will show the points at which the different elevations were taken, the same numbers being used on the map as in the above list.

The highest point at which shells were found is on the southwest side of Cemetery hill, and near the northern limit of the Roman Catholic cemetery. The flat upper surface of the beach covers only a small area, and a road has been cut through it so as to partially obliterate its characters.

De Geer's beach is at the extreme east (true) of the Protestant cemetery, and is also partially cut by a road.

Regarding the elevation of beach No. 6, it may be said that the discrepancy between our determination and that of Goldthwait necessitated the running of a check, which confirmed our determination, and at the same time that of beach No. 2. The basis for Goldthwait's determination was the old city contour map of this part of the "Mountain," which is reproduced in Guide Book No. 3, Twelfth International Geological Congress. (Manuscript communication.) De Geer's determination was by barometer, so that the discrepancy in that case calls for no discussion.

In the case of beach No. 3 we have determined the elevation of a point higher than that taken by Goldthwait, who took the point where shells were to be found in this beach.

Beach No. 7, the highest on Westmount, shows a fairly flat upper surface, as good a beach flat as can be found on the high levels, and is to be seen on the higher side of the road at the head of Lansdowne skew. Whilst this is the highest yet recorded on Westmount it is expected that with the removal of the vegetation on the higher slopes, one or two higher beaches will be discovered.

In the case of beach No. 11, which is supposed to be that described by Lyell, the top of the gravel was taken, and not the top of the material overlying it.

Of the lower beaches, the level of Nos. 18 and 19 is well-marked, that of Nos. 20 to 22 is an important and distinct level, Nos. 24 to 27 and 30 to 32 are very clearly marked series, whilst the latter (Nos. 30 to 32), and Nos. 33 to 36 show the correspondence which can be found between levels in different parts of the city. The Nos. 37 to 38 level is also well-marked, and the Nos. 41 to 44 level is the Sherbrooke Street terrace, which is found on St. Catherine street from Bishop to Guy streets and farther w

Beach No. 39 is clear and distinct, and it is considered that if further determinations were to be made a series of correspondent elevations with this level would be obtained.

Beach No. 40 corresponds in general stratigraphy with the Sherbrooke Street terrace, and very probably corresponds with it. The sand as there developed, however, is much thicker than that of the Sherbrooke Street terrace in the city, and also shows some evidence of dune formation.

Nos. 45 and 46 represent a beach below the Sherbrooke Street level, which is found on St. Catherine street from Bleury to Windsor streets. It may be found on Dorchester street, perhaps, but it has not been followed farther than the limits indicated. It is a beach with a restricted area, when compared with the Sherbrooke Street beach.

It will be seen from the variation in the figures given for levels regarded as distinct and separate, that any attempt to tie in these lower, intermediate levels with those of other areas will be a matter requiring considerable care. In referring to any one of these general levels the highest elevation of the group should be taken.

RIVER GRAVELS.

There is a broad strip of coarse river gravel extending along the right bank of the Rivière-des-Prairies, from Bas au Sault to Paton island, having a maximum width of three-quarters of a mile, and extending higher than the 100-foot contour line. The gravel is usually rich in large rounded pebbles, has a yellowish colour, and a sandy or gravelly character. At times the large pebbles are unusually abundant. This gravel, as a rule, rests upon the boulder clay, but sometimes upon a thin stratum of Leda clay, which occurs between the gravel and boulder clay. An interesting exposure occurs on the Côte St. Michel crossroad, 726 yards from the Ste. Geneviève road. Here the gravel rests upon an eroded surface of stratified Leda clay, which is not exposed at the surface, and the coarser pebbles of the gravel (here only up to

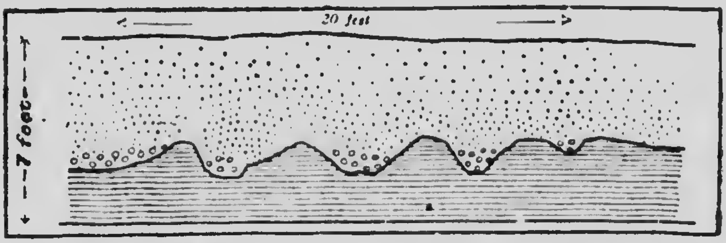

Figure 7. Vertical section of river gravel overlying erosion surface of Leda clay. Larger pebbles of the gravel are found in the hollows, in the upper surface of the clay. Côte St. Michel crossroad.

2 inches in diameter), are found in the hollows of the eroded surface, as though hollows had been formed by the churning action of the pebbles now resting in them (See Figure 7).

There is a patch of gravel a quarter of a mile wide and one and a quarter miles long on the southeast side of the Lachine canal, capping the ridge facing the canal, immediately to the west of Boulevard St. Paul. This gravel extends above the 100-foot contour, and in the absence of fossils is considered to be a river gravel. A section through it was exposed in the cut for a Canadian Pacific Railway switch at the new plant of the Montreal Light, Heat, and Power Company (see above). As Figure 10 (page 42), illustrating this cut shows, the gravel overlies the quicksand variety of the boulder clay at the face of the cliff, and the true boulder clay farther back from the edge of the cliff. The gravel at the edge of the cliff is 10 feet thick (thinning away from the face), and the lower 1½ feet has coarse pebbles and boulders. Above that is a 3-foot layer of gravel with rolled pebbles or pellets of Leda clay, 6 inches with occasional pebbles and Leda clay pellets, and 5 feet of brownish sand at the surface.

Near Dorval station there are a few patches of yellowish sand which rest upon the boulder clay and carry no fossils. The highest point (not determined) is between 90 and 100 feet above sea-level. This is here treated as river sand in the absence of definite evidence. Its presence has been taken advantage of in constructing a race course.

There is a patch of yellowish sand which was exposed at the crossing of Pie IX avenue and St. Catherine street, which is also considered to be river sand.

At the corner of St. Antoine and Cathedral streets, Leda clay is overlain by made ground (5 feet) in the middle of St. Antoine street. But, on the south side of the street, there is at least 10 feet of a coarse gravel, whose base was not exposed. This gravel extends down Cathedral street, though often covered by made ground, to St. James street, where there is at least 22 feet of this coarse gravel with a grey coarse sandy matrix. It is considered to be a river gravel.

Excavations on both sides of St. James street, near Place d'Armes, have shown considerable thicknesses of partially stratified gravel. The full interpretation of these gravels must await the collection of further data. They appear to suggest a former bed of the St. Lawrence.

DRAINED LAKE DEPOSITS.

The most recent natural deposits of the island consist of stratified clays, shell marl, and peat, and have been laid down on the floors of lakes which have been drained since the country was occupied by the white man. Two small lake areas were found on the line of the aqueduct, both with shell marl overlain by peat, and the western one showing stratified lake clay below the marl.

The largest of the lakes of the island, which might be called Lake Turcot, extended from Montreal West station on the Grand Trunk railway to Côte St. Paul road and probably farther east, since marl and peat have been disclosed by excavations at the crossing of Workman street and Greene avenue, and at the corner of Lusignan and St. James streets.

A small lake formerly existed in the course of Molson creek. A section through it showed marl near the surface at the west side of the drained lake, but toward the centre of the area the marl layer rested upon boulder clay and was overlain by 8 feet of a bluish, unstratified lake clay, exactly similar in appearance to unstratified Leda clay.

There is an area underlain by black-brown peat with marl below it on the Côte St. Michel crossroad about 1 mile north from the crossing of the Côte St. Michel road.

The crossing of Côte-des-Neiges road with the electric car line in Côte-des-Neiges village, is about the centre of a small circular area of 100 yards diameter, which was formerly a lake. A section exposed during 1912 showed below the made ground at the surface:

1 ft., peat.

5 to 6 ft., white shell marl, very rich in freshwater gasteropods.

2 ft., black sand with Saxicava, Macoma, and Mytilus.

Two small lakes, with marl deposits overlain by black muck, have been brought to light during the summer of 1914 about half a mile east of Pointe Claire.

The marl of these old lakes is a pure calcium carbonate and consists of the broken shells of fresh-water gasteropods, which are living in the lakes of the present day; but it also includes large numbers of unbroken shells, which are very fragile. The thickest marl deposit noticed was that at Côte-des-Neiges, and in it the richest fauna was found. For a list of the shells obtained see page 68.

CHAPTER III.

RECURRENCE OF GLACIATION.

Particular attention has been paid to the search for any evidence bearing upon the question of the recurrence of glaciation. Whilst the evidence so far gained may not be universally regarded as convincingly in favour of recurrence, yet it is of such a nature as to demand careful consideration. Certain sections will be described with regard to their relation to this problem, and it may be that the future will bring forth additional evidence of a similar type.

The foundation of the school recently erected on Melville street, Westmount, showed boulder clay in the western part, which was overlain, toward the east, by a thickness of 8 or 10 feet of gravels, with a narrow included band of clay, and one of sand. Boulder clay lay on top of the gravels on both sides of the cut. The gravels and sand show stratification very well indeed, but carry no fossils. They clearly indicate the agency of water deposition, whether marine or fluvio-glacial cannot be said, with a subsequent return to glacial conditions. This indicates either a recurrence, or fluctuation of the ice-front. The section is shown in Plate II, B.

At the excavation at the northeast corner of Metcalfe and Dorchester streets for the Sun Life building, the exposure in the southeast corner showed:

1 ft., gravelly clay, referred to Leda clay.
5 ft., yellowish oxidized boulder clay.
10 ft., bluish-grey boulder clay, which extends to 37 feet from the surface.

The north side of the excavation showed in the eastern corner:

3 ft., bluish-grey boulder clay.
4 ft., yellowish, oxidized boulder clay.
12 ft., bluish-grey boulder clay.

The upper 3 feet had every appearance of a true boulder clay, and the weathered surface below at once suggested two morainic deposits. The line of junction between the two was distinct, but a careful search along it revealed a few chips of Trenton limestone such as are made in dressing stone. So the upper 3 feet is made ground. The capacity of disturbed boulder clay for packing itself should be emphasized. After standing for a little time it takes on exactly the appearance of undisturbed boulder clay. Usually such a disturbed clay will contain small fragments of brick, etc., but that cannot be relied upon always, as in the case just given.

On the north side of Viateur street, half a block east of Outremont avenue, an excavation for a house foundation showed 3 feet of Saxicava-bearing gravel overlain by 1½ feet of boulder clay at the side next to the street. In the northwest corner the boulder clay rested directly on the limestone without any intervening gravel. No evidence of disturbance of the boulder clay (such as brick, etc.), could be obtained. Further evidence should be awaited from this locality before drawing any conclusions.

A trench on Montclair avenue, north from Sherbrooke street, showed very interesting relations. At the Sherbrooke Street end, 5 feet of boulder clay (the upper 2 feet oxidized to yellow), were overlain by 3½ feet of sandy gravel with boulders. Fifty feet north of Sherbrooke street 6 feet of boulder clay overlay 4 feet of yellow, cross-bedded sand without fossils. One hundred feet from Sherbrooke street the whole 10 feet of the trench is occupied by the yellow sand, and 200 feet from Sherbrooke street the sand is overlain by a sandy boulder clay.

Also, on King Edward avenue, for 200 feet north of Sherbrooke street, a trench 11 feet deep showed from 2 to 3½ feet gravel with shell fragments and rounded pebbles overlying cross-bedded sand, the cross-bedding dipping toward Sherbrooke street. At 400 feet from Sherbrooke street boulder clay was exposed at the surface.

Three excavations were examined at the place where the new Loyola college is being erected. At the Administration block a 4½-foot excavation showed stratified gravel, with dirty brown earthy matrix and a large proportion of pebbles of the average diameter of 2 inches, many of the pebbles being of Utica shale, and many of trap. All the pebbles are much weathered and soft. Fragments of shells were found to occur sparingly in the gravel. At one point a greyish-yellow sand was exposed beneath the gravel, the bedding of the sand dipping at 15 degrees toward Sherbrooke street.

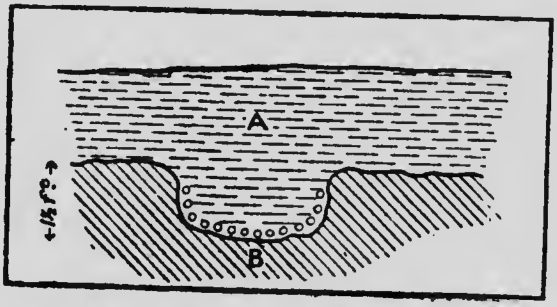

Figure 8. Partial section at Loyola college, Montreal West, showing shell-bearing gravel (A), overlying unconformably a fine unfossiliferous, cross-bedded sand (B).

The excavation at the Junior block was the most interesting, and extended to a depth of 11 feet, the surface at this point being 2 or 3 feet lower than the surface at the Administration

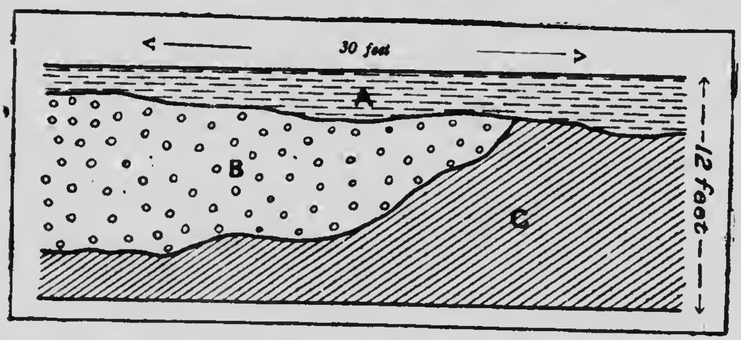

Figure 9. Section of Loyola college, Montreal West, showing cross-bedded sand (C), overlain by boulder clay (B), and both by shell-bearing gravel (A).

block. For the most part there was nothing exposed except beautifully cross-bedded, fine sand of light colour, with a cover of 2 to 3 feet of dark, dirty gravel with shell fragments, similar to that seen at the Administration block. The contact between the two was always sharp and distinct. A local detail of this contact is diagrammatically reproduced in Figure 8. In the northwest corner of the excavation, however, a mass of boulder clay was seen to overlie the sand, and the shell-bearing gravel above both was clearly marked off from them, as was the boulder clay from the sand. There was no evidence of disturbance of the sand. The boulder clay had a clayey matrix for the most part, but in part a sandy matrix, and was of a yellowish brown to brown colour. The conditions a[illegible] in Figure 9.

The shallow excavation at the Engine [illegible]k. where the surface was a foot or two lower than at the [illegible]cavation, showed that the boulder clay was continued in that direction and that in some parts it was covered by the gravel, whilst at other points the gravel had been removed by erosion, or else never deposited.

The cross-bedded sand is clearly a water-laid deposit, and the cross-bedding always dips toward Sherbrooke street. The boulder clay overlying, and in part displacing the sand, has all the characters of a true boulder clay of glacial origin. It is strongly suggestive of a recurrence of glaciation, but by no means conclusive. The absence of any contortion in the sand strongly militates against the idea of recurrence of glaciation. The advance of an ice-sheet, or a glacier of alpine type, would be attended by extensive ploughing up and shearing of the materials over which it rode, especially if they were unconsolidated.

CHAPTER IV.

POST-GLACIAL MOVEMENTS.

FOLDING.

A partial section through the ridge along the top of which Notre Dame street runs in the centre of the City of Montreal, was exposed in October, 1893, to a depth of 27 feet, on Beaudry street between Craig and Notre Dame streets. Concerning this section Dr. F. D. Adams noted, in part, as follows:

"This cut shows that the ridge is apparently due to a puckering up of the drift. The anticlinal and synclinal structure is excellently seen, and is reproduced in the photograph (see Plate II A). The west face of the cut in which anticlinal and synclinal structure is displayed is remarkable for the steep slope of the northern face of the anticlinal, with a shallow curved face as shown in the diagram. All the material is so stiff that it is difficult to pick out with a pick axe. The boulders are about half and half of lower Silurian and gneiss, with a few of Montreal trap. Where Beaudry street meets the Canadian Pacific railway on the wharf there is an excavation, probably the beginning of the cut to meet that driven in from Craig street. There seemed to be a dip toward the river."

Concerning a cutting on Berri street, between Champs de Mars and Notre Dame streets, being made at the same time, Dr. Adams noted: "There is a distinct dip of the drift toward Champs de Mars. The steepest angle is about 45 degrees. The bands are not very sharply defined, but some have more abundant stones, whilst others are more yellow in colour. The cliff was not in so good a condition for observation as those on Beaudry street."

These occurrences appear to suggest "contortion" of the drift such as is formed by a re-advance of an ice-sheet. It might also be an original structure, parallel layers having been underlain by an unequally distributed mass of ice, and when the ice melted away the parallel layers slipped unequally into the cavity.

An excavation at the northeast corner of Ontario and St. Lawrence streets, which showed folding in the Leda clay, was examined by Dr. F. D. Adams, on June 27, 1906, who writes as follows:

"An examination was made to-day in the excavation for the foundation of Rodier's cigar factory. This lies on the south side of the block bounded by Ontario, St. Lawrence, and St. Charles Borromée streets, occupying the southern portion of the block, along Ontario street. The excavation, at the time of my visit, was carried down to a level of about 8 feet below St. Lawrence street at the rear of the excavation farthest from Ontario street. The strata passed through consist of stratified blue clay, in beds which are, as far as the eye can tell, horizontal. These hold, here and there, a glaciated stone, but are usually pure clay. The strata of this blue clay are seen to be thrown into a series of little folds measuring perhaps a foot across, looking somewhat like the folds in the barrel-quartz of Nova Scotia, and which were evidently produced by some movement in the stratified clay after its deposition.

The northern limit of this excavation is about 30 yards back from Ontario street."

FAULTING.

Faulting has been noticed at two localities, near Melville street, Westmount, and at the Montreal Light, Heat, and Power Company's new plant, near the Lachine canal.

The general relations of the boulder clays and the gravels at the Melville Street school have been described above (see page 36). The gravel exposed is 12 feet thick, and within the gravel is a layer of brownish yellow sand, 1½ feet thick, with a layer of brown clay, 2 to 8 inches thick, immediately on top of it. The gravels show curved stratification, suggesting a broad, low anticline, but this may be a depositional effect or may have been caused by the ice which deposited the boulder clay above. This structure is thrown into strong relief by the narrow band of brownish clay, which shows the almost diagrammatic "graben" or trough which has been formed by the collapse of the broad arch (See Plate II B). This collapse may have been caused by the same agency which caused the arching, if the arching be a secondary structure, or it may be due to an earthquake shock, or again, to collapse consequent upon melting out of an ice-mass originally covered in by the gravel.

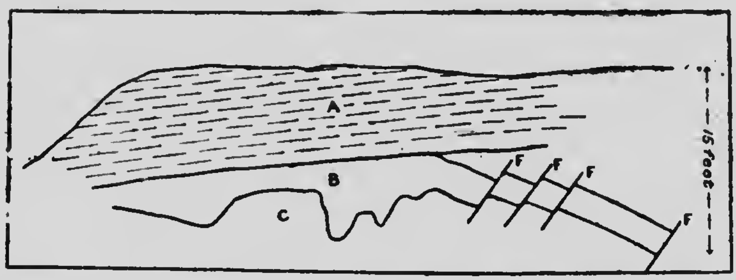

Figure 10. Vertical section at Montreal Light, Heat and Power Company's plant at railway cutting, southeast side of Lachine canal. A = river gravel; B = brown oxidized quicksand; C = bluish-grey unoxidized quicksand; F = fault planes.

The quicksand at the Montreal Light, Heat, and Power Company's new plant, discussed above, shows small faults which do not affect the gravel above. They are thrown into relief by reason of the different colour of the oxidized and unoxidized quicksand, and a stratification of the oxidized part. The faults are small, showing throws of only a few inches (See Figure 10). But the presence of faults in such a non-rigid mass as quicksand is sufficiently remarkable to deserve notice, and indicates that the cause must have been some sudden shock, such as an earthquake shock.

CHAPTER V.

ECONOMIC GEOLOGY.

UTILIZATION OF LEDA CLAY.

The Leda clay is used for the manufacture of common red brick, by the soft mud process at two points in the City of Montreal, viz., at the edge of the Sherbrooke Street terrace near Davidson, and near Iberville streets. The Saxicava sand is locally fine enough for sanding the moulds and for mixing with the clay, and has been partially stripped off the clay for these purposes.

At Lakeside, the Leda clay is utilized by the Terra Cotta Lumber Company, in the production of their hollow tiles for structural purposes. This represents the most important usage of the Leda clay for structural materials on the island. The bank of clay at Lakeside shows a non-stratified, or indistinctly stratified bluish clay in which *Leda glacialis* is fairly common. The cliff shows a thickness of 39 feet above the base of the mill. A well-boring at the mill showed 20 feet of similar clay, and 20 feet of sandy clay with gravel below it, which affords a stream of water which runs the year round. This is the thickest recorded section of Leda clay on the island, i.e., 59 feet, or 79 feet, if the sandy clay be included.

Mr. Keele's report on the Lakeside clay is appended:[1]

"A bluish-grey to brown, fine-grained, non-calcareous clay; 99 per cent passes through a 200-mesh sieve. Requires 30 per cent of water to bring it to a good working consistency. It has high plasticity, but is stiff, and hard to work. Brick-sized shapes can be dried slowly after moulding, at a temperature of 60 to 70 degrees F., but will crack if dried even moderately fast The drying shrinkage is rather high, being about 8 per cent. This clay burns to a light red, steel hard body at cone 010

[1] Keele, J., Preliminary Report on the Clay and Shale Deposits of the Province of Quebec, G.S.C. Memoir 64, 1915.

(1742 degrees F.), with an absorption of 15 per cent, and fire shrinkage of 1 per cent. When burned to cone 03 (2000 degrees F.), this clay becomes vitrified, with an abnormal shrinkage. It is easily over-fired and softened at temperatures higher than this.

"This clay is suitable for the manufacture of common brick, or field drain tile. It requires the addition of about 25 per cent of sand in order to reduce the shrinkage, and improve the working qualities. The commercial limit of burning is about cone 07 (1850 degrees F). The drying should be done outdoors, on racks and pallets, as any attempt to force the drying in artificial heat dryers would result in serious losses from checking. The fire-proofing made at Lakeside can be dried more safely, owing to the comparatively thin walls in this kind of ware, and on account of the sawdust included in the clay. Brick shapes are thicker and more difficult to dry."

At Longue Pointe the plants of the Canada Cement Company utilize the Leda clay, which is there found alongside the Trenton limestone, to a slight extent, to give the silicate admixture necessary in the manufacture of cement.

DEPTH AND CHARACTER OF DRIFT.

The choice of a site for a house should be governed, in part, by the character of the sub-soil. The foundations possible in Montreal and vicinity are, boulder clay, Leda clay, sand, gravel, and solid rock. The solid rock makes an ideal, but more costly, foundation. The boulder clay and Leda clay tend to give damp basements, and it is essential that good drainage be installed with these foundations. The sand and gravel foundations will give dry basements if the deeper drainage is right, which is the case, for the most part, with the sands and gravels of the island. It is to be noted that if the sand or gravel rest upon a basin-like surface of clay, a pool of stagnant water is liable to be formed upon the clay. Such conditions can be dangerous to health, as illustrated by the fact that the prevalence of phthisis in certain districts of the City of London has been ascribed to such sub-soil conditions. A similar state of affairs would exist, of course, in the case of a boulder clay, or Leda clay foundation with inferior drainage.

For stability of foundation solid rock is the ideal, but the boulder clay, in its normal development, is almost equally as good, after it has settled. The gravel foundations are also usually sound, for houses, but if there is any sub-stratum of Leda clay on any site, it should be viewed with suspicion. The many cracks developed in the houses and other buildings built upon the Leda clay between St. Catherine street and Sherbrooke street, and between Metcalfe and University streets, within the last few years, bear ample testimony to the unreliability of the Leda clay as a foundation for a residence.

The character and depth of the drift is of very great importance in the case of large buildings, or of important engineering works. The possibility of the presence of quicksands in the drift, as illustrated by the cases cited above, must be remembered constantly, and it is considered that it would be very sound policy for those contemplating the erection of large buildings, or the inception of large engineering departures, to make a careful study of the character and depth of the drift on the proposed site, before the actual commencement of operations. The acceptance or refusal of such a site should be made dependent upon favourable underground conditions. The cost of a preliminary examination of a thorough character is negligible when compared with the extra cost which would be entailed should the sub-soil prove to be of an unfavourable character. In some cases it is necessary to carry foundations to solid rock, but often, when the character of the subsoil is favourable, this is unnecessary. Here, it would be well to call attention to the large size occasionally attained by boulders in the boulder clay, and the necessity of continuing any boring for some 10 or 12 feet into the rock. Use of wash-out borings should be avoided, as a solid core best gives the information that it is desired to obtain.

No rule can be given for determination of conditions, except actual trial. Records from closely surrounding points may give no inkling of the true state of affairs at the point under consideration. An instructive example of the variability of the surface materials, which could not be judged from the superficial indications alone, is furnished by the corner block at the south-east corner of Sherbrooke street and Greene avenue. There the shallow surface excavation showed:

½ ft., weathered soil.

$$\left.\begin{array}{l}\text{1 ft., greenish clay.}\\ \text{2 ft., reddish clay.}\\ \text{3 ft., grey clay.}\end{array}\right\}\ \text{Leda clay.}$$

The southern half of the block was underlain, at a depth of 7 feet, by boulder clay which was good enough for a foundation, but the northern half of the block was underlain by Leda clay to a depth of from 24 to 27 feet, necessitating the driving of wooden piles to a depth of about 30 feet. These conditions could only be determined by trial.

In the lower part of the City of Montreal, say below Sherbrooke street, solid rock may be from 20 to 75 feet or more, from the surface. But a sufficiently safe foundation for most buildings is afforded by the boulder clay so long as it does not contain a development of quicksand. When the boulder clay reaches the surface, as for example, at the corner of Metcalfe and Dorchester streets, an excellent foundation is obtainable at whatever depth it may be desired. The excavation on this site was carried on practically without support for the sides, except where the proximity of other buildings made it essential. The boulder clay was of an exceptionally favourable character at this point.

Where gravel or Leda clay overlies the boulder clay it is necessary to drive wood or concrete piles at least into the boulder clay, or more preferably, as far as they will go. Another practice in vogue is the construction of concrete piles with spread footings.

When the boulder clay contains quicksand variations, it may become necessary to sink caissons under air at the pressure required to keep the quicksand from coming in on the caisson, until bed-rock is reached. The foundation can then be placed directly upon it.

Study of such figures as are available, regarding the depth of bed-rock from the surface in the City of Montreal affords certain generalizations of the weightiest import from the engineering point of view, as well as others of a more purely scientific bearing.

The area in which bed-rock closely approaches the surface, i.e., in which rock is usually not more than 5 feet and only seldom more than 10 feet from the surface, can be defined fairly closely. On an accompanying map, a line (the 10 foot bed-rock contour) has been plotted to indicate this area. From a point about 200 feet south of Masson avenue, on Avenue Pie IX, the line runs through the Angus shops and approximately along Mount Royal avenue, passing to the south of this avenue toward Papineau street, and on to Park and Pine avenues, with a swing to the north. From Pine and Park avenues it runs, by the University and Milton Street crossing, to a point about the head of Peel street on Sherbrooke street and thence approximately west along Sherbrooke street with bends to the south to the east and west of Guy street. Toward Atwater street the line passes north of Sherbrooke street and running a little north of Côte St. Antoine road toward Roslyn avenue it runs almost straight north to the head of Lansdowne skew, from where, with a nose toward the west it sweeps round to Côte-des-Neiges, skirting the south side of the village. Swinging out to the west again north of the village it turns east and runs between Côte St. Catherine road and the Canadian Pacific railway, approaching that railway toward Rockland avenue, and crossing it for a small space east of Rockland avenue, after which it continues south of the Canadian Pacific railway, crossing it again about Park avenue and, swinging almost due north, follows a course between the Bordeaux branch of the Canadian Pacific railway and Alice street, at the head of which street it turns again to the east and runs parallel, and a little north of, the Côte St. Michel road. Some few small areas will be found within the area as defined, where the rock is a little farther from the surface than indicated above.

Speaking quite generally it may be said that within the area as above delineated, a solid rock foundation may be found within easy reach of the surface, and that this part of the city is, therefore, pre-eminently suitable for the construction of large factories, office buildings, or department stores, such as require a firm and solid foundation. Further, such large buildings could be erected with a far smaller expenditure on foundations than most similar buildings which might be erected between the line as sketched above and the river bank. The greater stability and smaller capital outlay should be strong points influencing the selection of sites within the area d[illegible] above for the erection of many large structures in [illegible]. It seems safe to predict that the area between P[illegible] avenue and Iberville street, north from Mount Royal avenue [illegible], and beyond the Canadian Pacific railway, will become an important business and manufacturing section some years hence.

Immediately south of the line as above [illegible] from Avenue Pie IX to Westmount, the rock [illegible], so that if the drift were removed from [illegible] distinct cliff along that line would be revealed, with a height [illegible] or more feet at almost all points. A rock foundation, the[illegible] is only to be found at a considerable depth below surface outside the more favourable area discussed above. An exception to this generalization is to be noted for an area just north of Ontario street, extending from about Moreau street to a little east of Avenue Pie IX, being only narrow at its western end whilst broadening to a width of one-third of a mile at its eastern end. This is an area where the-bed-rock reaches the surface.

In general, for the greater part of the city, the distance of bed-rock from the surface becomes gradually greater in passing toward the river bank. The suddenness and importance of the "sub-drift" cliff in the Trenton limestone is well indicated along University street, where rock reaches within a few feet of the surface at the corner of Milton street, whilst 300 to 600 feet nearer Sherbrooke street, rock cannot be found until a depth of from 47 to 52 feet from the surface is reached. The rock is found at a greater depth (from 60 to 90 feet), along the line of the eastern end of the Lachine canal, and south of St. James, Craig, and St. Catherine streets, in the eastern part of the city, whilst there appears to be a ridge of less deeply buried rock (12 to 26 feet), running about parallel to Bleury street, between Lagauchetière and Ontario streets, having a width of about half a mile, and having its central axis one block east of Bleury street, (i.e. St. George street). This section of the lower part of the city would appear to be the most favourable with regard to rock foundation requirements. This is illustrated by the accompanying section along the line GH (vide map).

In a general way it may be said that the bed-rock surface has a gradual slope toward the river, from the foot of the "sub-drift" cliff described above, a slope which can be compared with that of the actual surface over the same district, as may be seen from the sections accompanying the map.

The depth of the bed-rock from the surface, where known, has been plotted on a map of the city. This has enabled a line to be drawn on the map to indicate the limit of the area within which bed-rock is found within 10 feet from the surface (the 10-foot bed-rock contour). This line is based upon data available along almost its whole length and so is fairly accurate. Another line indicating the limit of the area within which the bed-rock is within 30 feet of the surface (the 30-foot bed-rock contour), has been outlined, but in this case the line is not based upon such exhaustive data. In consequence it must be considered as only very approximate, and showing only the general trend of the 30-foot bed-rock contour. It is expected that this line will need considerable adjustment as our knowledge increases.

A list of the data[1] on which these lines are based is given at the end of this chapter. The data has been arranged according to streets, which are put in alphabetical order. A great many of the points given are street crossings. In these cases the point will be found under the heading of the street which runs east and west. The street names used are, as far as possible, those in use at the present time (1914).

Study of the bed-rock contours also indicates that the Island of Montreal was a pre-Glacial feature, and that the present island differs little from its former condition, apart from the

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[1]The data have been obtained from the engineering department of the cities of Montreal, Westmount, and Outremont, from contractors and others, and from the Report on the Artesian Wells of Montreal by F. D. Adams and O. E. LeRoy, and from a manuscript report on the same subject, now in press, by C. L. Cumming.

lowering of elevations due to glaciation and the deposition of the drift during and after the Glacial period. The St. Lawrence river was a pre-Glacial feature, as was also the Rivière-des-Prairies. Immediately before the glacial period the Rivière-des-Prairies and the St. Lawrence swept round the sides of the island, the former in its present course, but the latter seems to have followed a course somewhat to the west of that it now holds. A great depression in the rock surface indicates that the St. Lawrence passed by way of Montreal West and the eastern end of the Lachine canal and drowned what is now the lower part of the City of Montreal under its waters, to a distance of at least one-third of a mile to the west of the present left bank of the river. The junction with the higher course of the river was somewhere west of Lachine, probably in the vicinity of Dorval. Whether this was the main channel of the river or not cannot be authoritatively stated, but after the Glacial period this old channel was filled with drift and the drainage diverted so that the whole volume of the river follows its present course round by the Lachine rapids, and at least one-third of a mile east of its former ourse off the eastern part of the City of Montreal and covering the flats below St. Lambert to a shallow depth. It is believed that even in post-Glacial time a part of the St. Lawrence drainage has followed the same line, which has only been abandoned in very recent time, geologically speaking, but further study will be required to establish this point.

Depth of Bed-rock at Points Included in the Accompanying Map of the City of Montreal.

	Feet.
Aird ave., Maisonneuve. Dominion Light, Heat, and Power Co	12
Albert st., 1000, Walter Baker Co	23
Amity-Parthenais sts., F. Galibert	38
Argyle ave., Westmount, halfway between Montrose and Beloeil aves	1
Arsene-Christophe Colombe aves	3
Aylwin st., 380 ft. S. of Hochelaga st	9
Bagg-Clarke sts	2

	Feet.
Beaubien-Boyer sts.	6
" -Christophe Colombe sts.	5
" -Dufferin sts.	3
" -Huntley sts.	6
" -Labelle sts.	5
" -St. André sts.	4
" -St. Denis sts.	10
" -St. Hubert sts.	4
Beaudry st., 112. C. Gurd.	60
Beaudry st., 618. Rowan Bros.	70
Beaver Hall, E. side, 200 ft. S. of Dorchester st.	19+
Belanger (Daniel)-Christophe Colombe sts.	11+
" -Huntley sts.	10
" -Labelle sts.	6
" -St. Denis sts.	11+
" -St. Hubert sts.	7½–9½
Bellechasse-Boyer sts.	0
" -Cowan sts.	4½
" -Christophe Colombe sts.	3½
" -Dufferin sts.	3½
" -Huntley sts.	4
" -Labelle sts.	2
" -St. André sts.	0
" -St. Denis sts.	8–9
" -St. Hubert sts.	3½
Bennett ave., Maisonneuve, Union Soap Co.	28
" Warden King Bros.	19
Bernard-Bloomfield aves.	7½–10
" -Champagneur aves.	6–8½
" -Davaar aves.	6
" -de l'Epée aves.	5–9
" -Durocher sts.	5–9
" -Outremont aves.	5
" -Querbes aves.	6
" -Rockland aves.	15½
" -Stuart aves	10

	Feet.
Berri st. 300 ft. N. of Mount Royal ave	6½
" 560 ft. N. " " " " (at Bienville st.)	3½
" 800 ft. N. " " " "	3½
" 1000 ft. N. " " " "	5
" 1250 ft. N. " " " "	7½
" at Carrière st	3½
Bienville-Mentana sts	9
" -Resthier sts	9
" -from Resthier to Massue sts	6–7
" -St. André sts	7
" -St. Etienne sts	5
" -St. Hubert sts	6
Bleury st., above Lagauchetière st	12
Boucher st. from Carrière to Rivard sts	7
" -Drolet sts	1
" St. Denis sts	5½
Boyce-Mercier boulevard	7
Boyer st. from Bellechasse to Defleuromont sts	0–3
" 190 feet S. of Gilford st	10
Britannia st., 123, A. L. Munro	50
Cadieux st., 420, Union Brewing Co	36
Canadian Pacific railway, Angus shops. Lunch room	8
" " Hochelaga	12
" " "	13
" " Outremont	25
" " Place Viger. Notre Dame st	120
" " St. André st	0
" " Windsor sta., Osborne st	26
" " St. Antoine st	34
Carmel st.-Drolet st	1
Carmel-St. Denis sts	6
Carrière st.-Amherst st	4
" -Canadian Pacific railway	0
" -Dufferin st	6½
" -M. Rheaume	10
" -Papineau ave	10½+
" -Sherbrooke ave	5

	Feet.
Carriére st.-St. Etienne st	4½
" -St. Hubert st	5
" -Iberville st., Molson Park estate	21
" " "	13
" " "	5
Clarke st., Montreal, just above Mount Royal ave.	6–8
" 595, Montreal Weaving Co	5
Clarke st., Westmount, ½ distance from Westmount boulevard to Montrose ave	10
Côte-des-Neiges, F. Goyer	25
" " G. Goyer	5
Côte-des-Neiges rd.-MacGregor st	7½
" " -Pine ave	2
" " -Summerhill ave	7
" " -130 feet S. of Pine ave	8
" " -between MacGregor st. and Summerhill ave	3
Côte St. Catherine rd., Pensionnat du Saint Nom de Marie	5
Côte St. Catherine rd.,-Dunlop ave	8+
" -Pagnuelo ave	11+
" -Sunset ave	6
Côte St. Michel rd.-St. Hubert st	5½
Côte St. Louis rd.-Carrière st	1
" -Drolet st	1
" -Rivard st	3
" -St. Denis st	3
Craig St., 208., Laurentain Spring Water Co	67
" " " " "	60
" -St. Urbain st., N.W. corner	75+
Dandurand st.-Delorimier ave	5
" -Jeanne d'Arc ave	3
" -Pie IX ave	0
" -Sixth ave	4
" -Tenth ave	4
" -Third ave	1

	Feet.
Davaar ave. 210 ft. S. of Van Horne ave	10
" - 800 ft. S. "	0
" -1000 ft. S. "	10½
" -1200 ft. S. "	10½
" -1500 ft. S. "	7
" -1680 ft. S. "	10
Davidson st., 260 ft. N. of Forsyth st	9
" 400 ft. S. of Sherbrooke st	7
Defleuromont-Christophe Colombe sts	1½
" -Huntley sts	4
" -Iberville sts	6
" -Labelle sts	4½
" -Sherbrooke ave	0
" -St. André sts	6
" -St. Denis sts	6
" -St. Hubert sts	6½
de Grosbois ave.-Boulevard Mercier	1
Delisle ave., 187, Thomas Davidson Manufacturing Co.	50
Delorimier ave., 208, Canadian Brewing Co.	50
" " "	67
" 209, Globe Woollen mills	35
Dezery st., 330 ft. S. of Nolan st	11
" 460 ft. N. of Hochelaga st	11
Dorchester st., 808–10, H. Gatehouse	46
" -Metcalfe st. N.E. corner	37
" -Union ave., N.W. corner	30½
Dominion sq., Windsor hotel	25
Drolet st.-Boucher st	2
" -Côte St. Louis rd	3½
" -500 ft. S. of Côte St. Louis rd	6½
" -600 ft. S. of Côte St. Louis rd	3
Drummond st., E. side, Y.M.C.A.	34
-W. side, between St. Catherine and Dorchester sts.	24
Ducharme ave.-Champagneur ave	8
" -Bloomfield ave.	6
" -de l'Epée ave	3

	Feet
Ducharme ave.-Durocher st	9
“ -Outremont ave	10+
“ -Querbes ave	7
Dufferin st., from Bellechasse to Defleuromont sts	0
“ 120 ft. S. of St. Zotique st	8
“ 500 ft. S. “ “ “	9½
Duluth-St. Lawrence sts., N.W. corner, Vineberg bldg	4–8
Dunlop ave., 400 ft. N. of Côte St. Catherine rd	12
“ 600 ft. N. “ “ “	1
“ 980 ft. N. “ “ “	8
Du Palais st.-Rivard st	6
Dupré-Carrière sts	6½
“ -270 ft. W. of Carrière st	6½
Durocher st., between Bernard ave. and St. Viateur st.	11+
Everett-St. Hubert sts	0
Fairmount st.-de l'Epée ave	9
First ave., Maisonneuve, L'Air Liquide sociéte	22
Forden st., ½ distance from Montrose ave., to Côte St. Antoine rd	2
Forsyth-Chambly sts	12
“ -Dezery sts	7
“ -Nicolet sts	10
“ -St. Germain sts	9+
Frontenac st. 900 ft. S. of Verchères st	8
“ near Abbatoirs, Ice Manufacturing Co.	26
“ 141, Fenlin Leather Co	60
“ A. Goyer	30
“ Montreal Abbattoirs	28
“ “ “	35
“ “ “	25
Garnier st., 260 ft. N. of Laurier ave	10
Gilford st.-Boyer st	9
“ -Fabre st	10+
“ -Iberville st	0
“ -Mentana st	6½
“ -Papineau ave	10+
“ -Resthier st	2½

	Feet.
Gilford st.-St. André st	7½
" -St. Etienne st	5
" -St. Hubert st	4
Girouard-Outremont aves	5
Glencoe ave.,-300 ft. S. of Côte St. Catherine rd	8
" -580 ft. S. " "	6
Guy st., 233-241, The Wire and Cable Co	57
Hochelaga st.-Aylwin st	4½
" -Chambly st	4
" -Davidson st	2
" -Dezery st	3
" -Joliette st	10
" -Moreau st	0
" -Nicolet st	6
" -St. Germain st	3
Holt st.-Third ave	4
Hughes st.-Christophe Colombe st	4
Hutchison st., halfway between Pine ave. and Prince Arthur st	6
Iberville st., 130 ft. N. of Mount Royal ave	11½
" 1704, Daoust, Lalonde, and Co	27
Jarry-St. Hubert sts	4½
Joliette st., 400 ft. N. of Hochelaga st	10
" 80 ft. S. of "	9
Joliette st., 126 ft. N. of Forsyth st	10½
Labelle st., 450 ft. N. of Bellechasse st	10
Lachine canal, near Seigneurs St. bridge, Belding, Paul, and Co	64
Lagauchetière st., 613, Stanley Dry Plate Co	22
Lajoie ave.-Bloomfield ave	3½
" -6 Champagneur ave	4
" -de l'Epée ave	1
" -Durocher st	3½
" -Outremont ave	7
" -Querbes st	4
" -Stuart ave	6
" -Wiseman ave	4

	Feet
Lasalle ave., Maisonneuve, 1113, Dominion Ice Co.	18
Laurier ave.-Breboeuf st	1
" -Chambord st	2
" -160 ft. E. of Chambord st	9
" -de l'Epée ave	7
" -Garnier st	10+
" -Rivard st	3
" -St. André st	6
" -St. Denis st	5½
" -St. Hubert st	4
Laviolette-Outremont aves	8+
Longue Pointe, Montreal Locomotive and Machinery Co. Ltd	27
MacGregor st., E. of Côte-des-Neiges rd. for 210 ft. max:	12
" " " " " .....min:	3
" " " " " usually less than	6
Maisonneuve, Viau et Frères	90
Maisonneuve, Shawinigan Water and Power Co	21
" " " "	36
Market place, Maisonneuve, Maisonneuve baths	31
" " " "	36
Maplewood ave.-McCullough ave	0
" 500 ft. W. of McCullough ave	1
Marquette st., 290 ft. S. of Mount Royal ave	8½
" 4500 ft. S. of Laurier ave	3
" S. of latter point to Gilford st	8½-11+
" from point 400 ft. N. of Mount Royal ave. to Gilford st	11+
Marsolais ave.-Outremont ave	4
" -Wiseman ave	10
Masson st.-Fifth ave	0
" -Jeanne d'Arc ave	7½
" -Iberville st	13½+
" -1000 ft. E. of Iberville st	11
" -Papineau ave	8
" -Pie IX ave	8½

	Feet
Masson st.-Sixth ave	0
" -Tenth ave	11+
" -Third ave	7
McEachran-Stuart aves	5½
McGill College ave.-Jewish synagogue	50
Mile End, Frontenac brewery	2–3
" " Paterson Manufacturing Co	5
Milton-University sts., N.W. corner	3–7
Montmorency st., 150, Canadian Sugar Refining Co	70
Montrose ave.-Argyle ave	1
" -Clarke ave., Westmount	8
Moreau st., 350 ft. S. of Nolan st	16
" 356, Crown Shoe and Leather Co	32
Morin st.-Labelle st	0
" -St. Hubert st.	2
Mount Royal ave.-Berri st	5
" -Boyer st	9½+
" -Carrière st	6½
" -Clarke st., Montreal	2
" -Iberville st	12+
" -Mance st	5
" -Marquette st	0
" -Papineau ave., N.E. corner	7
" - " " centre	4
" -Resthier st	9
" -Rivard st	9
" -St. André st	9
" -St. Denis st	9½
" -St. Etienne st	6
Mount Royal Park, "Park Well"	4
Mountain st., J. D. Duncan Co	41
Mount Stephen ave., ¼ distance from Côte St. Antoine rd. to Sherbrooke st	4
Mousseau ave.-Boulevard Mercier	1½
Napoleon st.-City Hall ave	8
" " -St. Dominique st	6½
Nicolet st., 600 ft. N. of Hochelaga st	6½

	Feet
Ninco ave.,-370 ft. S. of Masson ave	12½
" -420 ft. S. "	4
" -600 ft. S. "	0
Nolan St.-Dezery st	5
" -Moreau st	2
" -950 ft. E. of Moreau st	13
" -St. Germain st	9
Notre Dame de Grace, Convent of the Precious Blood	42
" " " Sisters of Providence	26
Notre Dame st., Canadian Rubber Co	70
" " Maisonneuve, Canadian Spool Cotton Co	168
Notre Dame st., 2082, A.S. and W. S. Masterman	68
" " 1006, J. H. R. Molson Bros	83
Notre Dame st., 1334, Montreal Brewing Co	80
" -McGill st., S.E. corner	75
Ontario ave., at Sherbrooke st	8
" -500 ft. N. of Sherbrooke st	2
" -640 ft. N. "	0
" -740 ft. N. "	5
" -850 ft. N. "	1
Ontario st.-Desjardins st., Dufresne and Locke	40
" -Nicolet st	14½+
" -St. Lawrence st., S.W. corner	26
" -967, Excelsior Woollen Mills	35
Ottawa st., Montreal Gas Co	90
Outremont, A. Hobbs	5
" Montreal Hunt club	0
Oxenden ave.-Lorne crescent	0
Parc Lafontaine, T. Cushing	68
Pagnuelo ave. 100 ft. S. of Côte St. Catherine rd	9
" 700 ft. S. " "	6
Average over the distance	2–3
Papineau ave., 1675, M. Groisboyeau	0
" 290, Montreal Dairy Co	42
" Canadian Pacific railway	7½
" 130 ft. S. of Carrière st	11

	Feet
Park ave., Outremont, Montreal Milling Co.	0
Peel st., at Pine ave.	0
" 300 ft. S. of Pine ave.	4½
" 500 ft. S. "	7
" 550 ft. S. "	6
Pie IX ave., 230 ft. N. of Masson ave.	3
" 360 ft. N. "	8½
" 230 ft. S. "	10½
Pine ave.,-Royal Victoria hospital	10
" -Basset st.	2½
" -Durocher st.	2
" -Mountain st.	3½
" -Park ave.	6
" -Redpath st.	8½
" -from 270 ft. to 620 ft. W. of Simpson st.	3–9
" -St. Famille st.	3
Place Youville, adjoining Sailors' institute	79
Prince Arthur st.-Oxenden ave.	5½
" -Shuter st.	5
" -60 ft. E. of Shuter st.	12
" -University st.	2
" -200 ft. E. of University st.	4
Quebec st.-de l'Epée ave.	10
Rachel st.-Esplanade st.	4½
Rachel st.-St. Urbain st.	5
Rivard st., 611, Canada Bread Co.	19
" 600, Independent breweries	10
" 195 feet N. of Mount Royal ave.	4½
" 500 " N. " "	8
" 510 " N. " "	3
" 800 " N. " "	5
" 950 " N. " "	10+
" 1050 " N. " "	10+
" at Carrière st.	7
Rockland ave., 500 ft. N. of Bernard ave.	2–3
Rose de Lima st.-St. Hubert st.	5½
Rosemount boulevard (Petite Côte rd.), A. Drummond	5

	Feet
Rosemount boulevard, 2501, S. Nesbitt	12
“ “ -Iberville st.	10
“ “ -Jeanne d'Arc st.	4
“ “ -Pie IX ave.	7
“ “ -Sixth ave.	3
“ “ -Third ave.	0
Seventh ave., 140 ft. S. of Masson ave.	8
“ 230 ft. S. “	8
“ 540 ft. S. “	10½+
“ 620 ft. S. “	11½
“ 670 ft. S. “	3
“ 100 ft. S. of St. Jerome st.	2
“ 470 ft. S. “	7½
Shearer st., 107, F. Schnaufer	47
Sherbrooke st.-Bishop st.	11½
“ -Drummond st., N.W. corner	4½
“ “ “ centre road	9½
“ -Guy st.	12
“ -Mackay st.	15
“ -Mansfield, Maxwelton apt.	58
“ -McGill union	46
“ -Mercier boulevard	3
“ -Mountain st.	11½
“ -Peel st.	14½
“ -Simpson st.	9
“ -Stanley st., Unitarian church	4
“ “ “ centre road	11
“ -50 ft. W. of Peel st.	13
“ -Union ave., S.E. corner	30–35 ?
St. André st., 975, T. J. Joubert	51
St. Antoine st., 900, Imperial Tobacco Co. of Canada	20
St. Catherine st.-Bishop st., S.W. corner	33+
“ -Crescent st., N.W. corner	25–35 ?
“ -Drummond st., Willis building	24
“ -929, F. Galibert	56
“ -Guaranteed Pure Milk Co.	40
“ -Hallowell st.	33+

	Feet
St. Catherine st.-Parthenais st., Laing and Sons	56
" -Peel st., Drummond building	22
" -Peel st., Holland building	30-34
St. Cuthbert st.-St. Emilie st	5
St. Denis st.-F. L. Baugh and Co.	33
" -Canadian Pacific railway	5½-9
" -S. of St. Zotique st	10
St. Germain st., 240 ft. S. of Nolan st	10
" 400 ft. N. of Hochelaga st	19
" 170 ft. N. of Forsyth st	9
St. Gregoire st.-Breboeuf st	3
" -Garnier st	0
St. Henri, Abattoir site, Canada Malting Co.	30
" Montreal Light, Heat, and Power Co.	34
St. Hubert st., 950 ft. N. of St. Zotique st	10
St. James st.-McGill st., Bank of Toronto bldg.	71
" -St. Francois Xavier st., Dom. Exp. bldg.	70 to 75
" -Place d'Armes, Bank of Montreal	89 app.
St. Jean Baptiste-Pagnuelo ave	4½
" " -225 ft. E. of Pagnuelo ave	4
St. Jerome st.-Ninth ave	2
" -Seventh ave	2
" -Fifth ave	5
St. Joseph boulevard-Esplanade st	4½
" " -Mance st	0
" " -Park ave	4
" " -St. Urbain st	4
St. Joseph st.-Carrière st	3
" -270 ft. W. of Carrière st	3
St. Joseph st.-St. Denis st	9
" -150 ft. E. of St. Denis st	9½
St. Just st.-Outremont ave	12+
St. Lawrence st., 409, Eker's brewery	70
" 2275, J. W. Peck	2
St. Louis sq., S. side	61
Ste. Monique st., 140, Turkish baths	50
St. Paul st., 60, Montreal Cold Storage Co	60

	Feet
St. Paul st., 617, Salvador Brewing Co.	62
St. Urbain st., 2984, Bramœram Henderson Co	37
St. Viateur st.-Bloomfield ave.	3
" -de l'Epée ave	3½
" -Durocher st	7
" -Outremont ave.	10+
" -Stuart ave.	10½
St. Zotique st.-Boyer st.	6
" -Christophe Colombe st.	7
" -Dufferin st	8½
" -Huntley st.	9+
" -Labelle st.	5½
" -St. André st.	8
" -St. Denis st.	10+
" -St. Hubert st.	6½
Stanley st., Windsor hotel, Power house	30
Strathcona ave., ⅓ distance from Sherbrooke st. to Côte St. Antoine rd.	4-5
Sunset ave., 300 ft. S. of Côte St. Catherine rd.	0
Tenth ave., 120 ft. N. of Dandurand st.	12½
University st.-High school	47-52
" -McGill New Medical building	2
Van Horne ave.-Beaubien st.	[illegible]
" " -Bloomfield ave.	6
" " -Canadian Pacific railway	10½
" " -Champagneur ave.	4
" " -Davaar ave.	12+
" " -de l'Epée ave.	3
" " -Durocher st.	4
" " -Atlantic ave.	4
" " -Hartland ave.	10+
" " -Hutchison st.	8½+
" " -550 ft. W. of Hutchison st.	10
" " -McEachran ave.	14½+
" " -Outremont ave.	4
" " -Querbes ave.	5
" " -Rockland ave.	0

	Feet
Van Horne ave.-Stuart ave.	3
" " -Wilder ave.	7½
" " -Wiseman ave.	3
" -50 ft. E. of Wiseman ave.	10+
" Smith Bros Co.	11
Verchères st.-Frontenac st.	2½
" -500 ft. E. of Frontenac st.	16½
" -Fifth ave.	10+
Villeneuve st.-Esplanade st.	1
" -Mance st.	1
" -Park ave.	9
" -St. Urbain st.	7
Ville St. Louis, Bushnell Oil Co.	0
William st.-Grey Nun st., Gould Cold Storage Co.	73
" -63, Lovell and Christmas	62
" -169, W. Lowney & Co.	63
" -Vinet st., Dominion Wadding Co.	90
Winchester st.-Claremont ave.	3½
Youville square-McGill st., Examining warehouse	74

CHAPTER VI.

FOSSILS FROM THE PLEISTOCENE AND RECENT DEPOSITS.

LIST OF FOSSILS FROM THE LEDA CLAY OF THE ISLAND OF MONTREAL.

Foraminifera.

Nodosaria laevigata.
Entosolenia sulcata.
E. marginata.
Bulimina presli.
Orbulina universa.
Polystromella crispa.
Cornuspira foliacea.
Biloculina ringens.
Lagena sulcata.
Entosolenia costata.
E. squamosa.
Polymorphina lactea.
Pulvinulina repanda.
Nonionina scapha.
Quinqueloculina seminulum.

Porifera.

Tethea logani, Dawson.
Tethea ?

Echinodermata.

Ophiacantha spinulosa, M. and T.
Solaster papposa.
Amphiura sp.
Euryechinus drobachiensis, Müller.

Holothuroidea.

Psolus fabricii, Dur. and Kor.

Bryozoa.

Lepralia quadricornuta, Dawson.
Crisea eburnea, Ellis.
Porella elegantula, D'Orbigny.

Brachiopoda.

Rhynchonella psittacea, Gm.

Lamellibranchiata.

Saxicava rugosa, Lamarck.
Lyonsia arenosa, Möller.
Macoma greenlandica, Beck.
M. inflata, Stimpson.
Cryptodon gouldii, Philippi.
Modiola modiolus, Linn.
Nucula tenuis, Montagu.
Leda minuta, Fabricius.

Mya truncata, Linn.
M. arenaria, Linn.
Macoma calcarea, Chemnitz.
Astarte laurentiana, Lyell.
Mytilus edulis, Linn.
Modiolaria nigra, Gray.
M. discors.
Ostrea virginiana, Lister.

Yoldia arctica, Gray. (Leda glacialis.)

Gasteropoda.

Philine lineolata, Couthuoy.
Haminea solitaria, Say.
Diaphena debilis, Gould.
Utriculus pertenuis, Mighels.

Cylichna alba, Brown.
C. oryza, Totten.
C. nucleola, Reeve.
C. occulta, Mighels and Adams.

Lymnea caperata, Say.
Lepeta coeca, Möller.
Cyclostrema costulata, Möller.
C. cutleriana, Clark.
Rissoa castanea, Möller.
R. exorata, Stimpson.
Natica clausa, Brod. and Sow.
Lunatia greenlandica, Beck.
Velutina zonata, Gould.
Acirsa eschrichtii, Holboll.

Amicula emersonii, Couthuoy
Margarita helicina, Fabricius.
M. argentata, Gould.
Turitella erosa, Couthuoy.
Cingula jan meyeni, Friele.
Bela harpularia, Couthuoy.
B. elegans, Möller.
B. pyramidalis, Ström.
B. turricula, Montagu
B. violacea, Mighels and Adams.

Trichotropis borealis, Brod. and Sow.
T. arctica, Middendorf.
Admete viridula, Fabricius
Ptychatractus ligatus, (Fascicolaria ligata, Mighels).
Buccinum greenlandicum Chemnitz.

B. ciliatum, Fabricius.
B. glaciale, Linn.
Trophon scalariforme, Gould.
Sipho spitzbergensis, Reeve.
Neptunea despecta, L.
Trophon clathratum, Linn.

Annulata.

Serpula vermicularis, Linn.
Spirorbis vitrea, Fabricius.

Crustacea.

Balanus hameri, Ascanius.
Balanus crenatus, Brug.

Mammalia.

Phoca greenlandica, Müller.
Beluga catodon.

Plants.

Menyanthes trifoliata, L.
Thuya occidentalis, L.
Larix americana. Michx.

LIST OF FOSSILS FROM THE SAXICAVA SAND OF THE ISLAND OF MONTREAL.

Lamellibranchiata.

Saxicava rugosa, Lamarck.
Macoma greenlandica, Beck.
M. inflata, Stimpson.
Mya truncata, Linn.
M. arenaria, Linn.
Mytilus edulis, Linn.

Gasteropoda.

Crepidula fornicata, L.
Capulus ungaricus, Lin.
Bela harpularia, Couthouy.
B. elegans, Möller.
B. pyramidalis, Strom.
B. turricula, Montagu.
B. violacea, Mighels and Adams.
Trichotropis borealis, Brod. and Sow.
Choristes elegans, Carpenter.
Cyclostrema costulata, Möller.
Natica clausa, Brod. and Sow.
Lunatia greenlandica, Beck.
Velutina zonata, Gould.
Acirsa eschrichtii, Holboll.

Crustacea.

Balanus hameri, Ascanius. Balanus crenatus, Brug.

LIST OF SHELLS FROM THE MARLS OF THE DRAINED LAKES ON THE ISLAND OF MONTREAL.

Gasteropoda.

Planorbis campanulatus, Say.
P. parvus, Say.
P. bicarinatus, Say.
Limnea stagnalis.
Valvata tricarinata, Say.
Physa heterostropha.
Amnicola porata.

Lamellibranchiata.

Sphaerium ? portumlium, Prime.

PLATE II.

A. Excavation on Beaudry street, showing the northern slope of the drift ridge which determined the site of the City of Montreal. The ridge is seen to be caused by the folding of the drift strata.

B. Faulting in stratified gravels and clays, at Westmount school, Melville street, east end. The dark band is a clay bed 2 inches to 8 inches in thickness.

PLATE II.

A

B

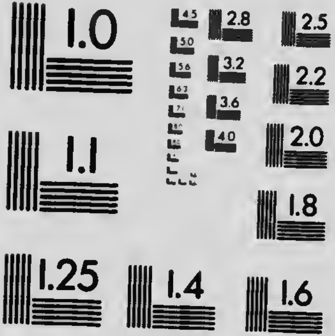
INDEX.

A.

B.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



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1653 East Main Street
Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
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I.

K.

L.

M.

N.

O.

P.

Q.

R.

S.

LIST OF RECENT REPORTS OF GEOLOGICAL SURVEY

Since 1910, reports issued by the Geological Survey have been called memoirs and have been numbered Memoir 1, Memoir 2, etc. Owing to delays incidental to the publishing of reports and their accompanying maps, not all of the reports have been called memoirs, and the memoirs have not been issued in the order of their assigned numbers and, therefore, the following list has been prepared to prevent any misconceptions arising on this account. The titles of all other important publications of the Geological Survey are incorporated in this list.

Memoirs and Reports Published During 1910.

REPORTS.

Report on a geological reconnaissance of the region traversed by the National Transcontinental railway between Lake Nipigon and Clay lake, Ont.—by W. H. Collins. No. 1059.

Report on the geological position and characteristics of the oil-shale deposits of Canada—by R. W. Ells. No. 1107.

A reconnaissance across the Mackenzie mountains on the Pelly, Ross, and Gravel rivers, Yukon and North West Territories—by Joseph Keele. No. 1097.

Summary Report for the calendar year 1909. No. 1120.

MEMOIRS—GEOLOGICAL SERIES.

MEMOIR 1. *No. 1, Geological Series.* Geology of the Nipigon basin, Ontario—by Alfred W. G. Wilson.

MEMOIR 2. *No. 2, Geological Series.* Geology and ore deposits of Hedley mining district, British Columbia—by Charles Camsell.

MEMOIR 3. *No. 3, Geological Series.* Palæoniscid fishes from the Albert shales of New Brunswick—by Lawrence M. Lambe.

MEMOIR 5. *No. 4, Geological Series.* Preliminary memoir on the Lewes and Nordenskiöld Rivers coal district, Yukon Territory—by D. D. Cairnes.

MEMOIR 6 *No. Geological Series.* Geology of the Haliburton and Ban-roft areas, Province of Ontario—by Frank D. Adams and lfred E. Barlow.

MEMOIR 7 *No. 6, Geological Series.* Geology of St. Bruno mountain, province of Quebec—by John A. Dresser.

MEMOIRS—TOPOGRAPHICAL SERIES.

MEMOIR 11. *No. 1, Topographical Series.* Triangulation and spirit levelling of Vancouver island, B.C., 1909—by R. H. Chapman.

Memoirs and Reports Published During 1911.

REPORTS.

Report on a traverse through the southern part of the North West Territories, from Lac Seul to Cat lake, in 1902—by Alfred W. G. Wilson. No. 1006.

Report on a part of the North West Territories drained by the Winisk and Upper Attawapiskat rivers—by W. McInnes. No. 1080.

Report on the geology of an area adjoining the east side of LakeTimiskaming—by Morley E. Wilson. No. 1064.

Summary Report for the calendar year 1910. No. 1170.

MEMOIRS—GEOLOGICAL SERIES.

MEMOIR 4. *No. 7, Geological Series.* Geological reconnaissance along the line of the National Transcontinental railway in western Quebec—by W. J. Wilson.

MEMOIR 8. *No. 8, Geological Series.* The Edmonton coal field, Alberta—by D. B. Dowling.

MEMOIR 9. *No. 9, Geological Series.* Bighorn coal basin, Alberta—by G. S. Malloch.

MEMOIR 10. *No. 10, Geological Series.* An instrumental survey of the shore-lines of the extinct lakes Algonquin and Nipissing in southwestern Ontario—by J. W. Goldthwait.

MEMOIR 12. *No. 11, Geological Series.* Insects from the Tertiary lake deposits of the southern interior of British Columbia, collected by Mr. Lawrence M. Lambe, in 1906—by Anton Handlirsch.

MEMOIR 15. *No. 12, Geological Series.* On a Trenton Echinoderm fauna at Kirkfield, Ontario—by Frank Springer.

MEMOIR 16. *No. 13, Geological Series.* The clay and shale deposits of Nova Scotia and portions of New Brunswick—by Heinrich Ries assisted by Joseph Keele.

MEMOIRS—BIOLOGICAL SERIES.

MEMOIR 14. *No. 1, Biological Series.* New species of shells collected by Mr. John Macoun at Barkley sound, Vancouver island, British Columbia—by William H. Dall and Paul Bartsch.

Memoirs and Reports Published During 1912.

REPORTS.

Summary Report for the calendar year 1911. No. 1218.

MEMOIRS—GEOLOGICAL SERIES.

MEMOIR 13. *No. 14, Geological Series.* Southern Vancouver island—by Charles H. Clapp.

MEMOIR 21. *No. 15, Geological Series.* The geology and ore deposits of Phoenix, Boundary district, British Columbia—by O. E. LeRoy.

MEMOIR 24. *No. 16, Geological Series.* Preliminary report on the clay and shale deposits of the western provinces—by Heinrich Ries and Joseph Keele.

MEMOIR 27. *No. 17, Geological Series.* Report of the Commission appointed to investigate Turtle mountain, Frank, Alberta, 1911.

M[illegible]. *No. 18, Geological Series.* The Geology of Steeprock lake, Ontario—by Andrew C. Lawson. Notes on fossils from limestone of Steeprock lake, Ontario—by Charles D. Walcott.

Memoirs and Reports Published During 1913.

REPORTS, ETC.

Museum Bulletin No. 1: contains articles Nos. 1 to 12 of the Geological Series of Museum Bulletins, articles Nos. 1 to 3 of the Biological Series of Museum Bulletins, and article No. 1 of the Anthropological Series of Museum Bulletins.

Guide Book No. 1. Excursions in eastern Quebec and the Maritime Provinces, parts 1 and 2.

Guide Book No. 2. Excursions in the Eastern Townships of Quebec and the eastern part of Ontario.
Guide Book No. 3. Excursions in the neighbourhood of Montreal and Ottawa.
Guide Book No. 4. Excursions in southwestern Ontario.
Guide Book No. 5. Excursions in the western peninsula of Ontario and Manitoulin island.
Guide Book No. 8. Toronto to Victoria and return *via* Canadian Pacific and Canadian Northern railways: parts 1, 2, and 3.
Guide Book No. 9. Toronto to Victoria and return *via* Canadian Pacific, Grand Trunk Pacific, and National Transcontinental railways.
Guide Book No. 10. Excursions in Northern British Columbia and Yukon Territory and along the north Pacific coast.

MEMOIRS—GEOLOGICAL SERIES.

Memoir 17. *No. 28, Geological Series.* Geology and economic resources of the Larder Lake district, Ont., and adjoining portions of Pontiac county, Que.—by Morley E. Wilson.
Memoir 18. *No. 19, Geological Series.* Bathurst district, New Brunswick—by G. A. Young.
Memoir 26. *No. 34, Geological Series.* Geology and mineral deposits of the Tulameen district, B.C.—by C. Camsell.
Memoir 29. *No. 32, Geological Series.* Oil and gas prospects of the north-west provinces of Canada—by W. Malcolm.
Memoir 31. *No. 20, Geological Series.* Wheaton district, Yukon Territory—by D. D. Cairnes.
Memoir 33. *No. 30, Geological Series.* The geology of Gowganda Mining Division—by W. H. Collins.
Memoir 35. *No. 29, Geological Series.* Reconnaissance along the National Transcontinental railway in southern Quebec—by John A. Dresser.
Memoir 37. *No. 22, Geological Series.* Portions of Atlin district, B.C.—by D. D. Cairnes.
Memoir 38. *No. 31, Geological Series.* Geology of the North American Cordillera at the forty-ninth parallel, Parts I and II—by Reginald Aldworth Daly.

Memoirs and Reports Published During 1914.

REPORTS, ETC.

Summary Report for the calendar year 1912. No. 1305.
Museum Bulletins Nos. 2, 3, 4, 5, 7, and 8 contain articles Nos. 13 to 22 of the Geological Series of Museum Bulletins, article No. 2 of the Anthropological Series, and article No. 4 of the Biological Series of Museum Bulletins.
Prospector's Handbook No. 1: Notes on radium-bearing minerals—by Wyatt Malcolm.

MUSEUM GUIDE BOOKS.

The archæological collection from the southern interior of British Columbia—by Harlan I. Smith. No. 1290.

MEMOIRS—GEOLOGICAL SERIES.

Memoir 23. *No. 23, Geological Series.* Geology of the Coast and islands between the Strait of Georgia and Queen Charlotte sound, B.C.—by J. Austen Bancroft.

Memoir 25. *No. 21, Geological Series.* Report on the clay and shale deposits of the western provinces (Part II)—by Heinrich Ries and Joseph Keele.

Memoir 30. *No. 40, Geological Series.* The basins of Nelson and Churchill rivers—by William McInnes.

Memoir 20. *No. 41, Geological Series.* Gold fields of Nova Scotia—by W. Malcolm.

Memoir 36. *No. 33, Geological Series.* Geology of the Victoria and Saanich map-areas, Vancouver island, B.C.—by C. H. Clapp.

Memoir 52. *No. 42, Geological Series.* Geological notes to accompany map of Sheep River gas and oil field, Alberta—by D. B. Dowling.

Memoir 43. *No. 36, Geological Series.* St. Hilaire (Beloeil) and Rougemont mountains, Quebec—by J. J. O'Neill.

Memoir 44. *No. 37, Geological Series.* Clay and shale deposits of New Brunswick—by J. Keele.

Memoir 22. *No. 27, Geological Series.* Preliminary report on the serpentines and associated rocks, in southern Quebec—by J. A. Dresser.

Memoir 32. *No. 25, Geological Series.* Portions of Portland Canal and Skeena Mining divisions, Skeena district, B.C.—by R. G. McConnell.

Memoir 47. *No. 39, Geological Series.* Clay and shale deposits of the western provinces, Part III—by Heinrich Ries.

Memoir 40. *No. 24, Geological Series.* The Archæan geology of Rainy lake—by Andrew C. Lawson.

Memoir 19. *No. 26, Geological Series.* Geology of Mother Lode and Sunset mines, Boundary district, B.C.—by O. E. LeRoy.

Memoir 39. *No. 35, Geological Series.* Kewagama Lake map-area, Quebec—by M. E. Wilson.

Memoir 51. *No. 43, Geological Series.* Geology of the Nanaimo map-area—by C. H. Clapp.

Memoir 61. *No. 45, Geological Series.* Moose Mountain district, southern Alberta (second edition)—by D. D. Cairnes.

Memoir 41. *No. 38, Geological Series.* The "Fern Ledges" Carboniferous flora of St. John, New Brunswick—by Marie C. Stopes.

Memoir 53. *No. 44, Geological Series.* Coal fields of Manitoba, Saskatchewan, Alberta, and eastern British Columbia (revised edition)—by D. B. Dowling.

Memoir 55. *No. 46, Geological Series.* Geology of Field map-area, Alberta and British Columbia—by John A. Allan.

MEMOIRS—ANTHROPOLOGICAL SERIES.

Memoir 48. *No. 2, Anthropological Series.* Some myths and tales of the Ojibwa of southeastern Ontario—collected by Paul Radin.

Memoir 45. *No. 3, Anthropological Series.* The inviting-in feast of the Alaskan Eskimo—by E. W. Hawkes.

Memoir 49. *No. 4, Anthropological Series.* Malecite tales—by W. H. Mechling.

Memoir 42. *No. 1, Anthropological Series.* The double curve motive in northeastern Algonkian art—by Frank G. Speck.

MEMOIRS—BIOLOGICAL SERIES.

Memoir 54. *No. 2, Biological Series.* Annotated list of flowering plants and ferns of Point Pelee, Ont., and neighbouring districts—by C. K. Dodge.

Memoirs and Reports Published During 1915.

REPORTS, ETC.

Summary Report for the calendar year 1913, No. 1359.

Report from Anthropological Division. Separate from Summary Report 1913.

Report from Topographical Division. Separate from Summary Report 1913.

Museum Bulletin No. 6. *No. 3, Anthropological Series.* Pre-historic and present commerce among the Arctic Coast Eskimo—V. Stefansson.

Museum Bulletin No. 9. *No. 4, Anthropological Series.* The glenoid fossa in the skull of the Eskimo—F. H. S. Knowles.

Museum Bulletin No. 13. *No. 5, Biological Series.* The double crested cormorant (*Phalacrocorax auritus*). Its relation to the salmon industries on the Gulf of St. Lawrence—P A. Taverner.

MEMOIRS—GEOLOGICAL SERIES.

MEMOIR 58. *No. 48, Geological Series.* Texada island—by R. G. McConnell.

MEMOIR 60. *No. 47, Geological Series.* Arisaig-Antigonish district—by M. Y. Williams.

MEMOIR 67. *No. 49, Geological Series.* The Yukon-Alaska Boundary between Porcupine and Yukon rivers—by D. D. Cairnes.

MEMOIR 59. *No. 55, Geological Series.* Coal fields and coal resources of Canada—by D. B. Dowling.

MEMOIR 50. *No. 51, Geological Series.* Upper White River District, Yukon —by D. D. Cairnes.

MEMOIR 66. *No. 54, Geological Series.* Clay and shale deposits of the western provinces, Part V—by J. Keele.

MEMOIR 65. *No. 53, Geological Series.* Clay and shale deposits of the western provinces, Part IV—by H. Ries.

MEMOIR 56. *No. 56, Geological Series.* Geology of Franklin mining camp, B. C.—by Chas. W. Drysdale.

MEMOIR 64. *No. 52, Geological Series.* Preliminary report on the clay and shale deposits of the Province of Quebec—by J. Keele.

MEMOIR 57. *No. 50, Geological Series.* Corundum, its occurrence, distribution, exploitation, and uses—by A. E. Barlow.

Memoirs and Reports in Press, May 8, 1915.

MEMOIR 62. *No. 5, Anthropological Series.* Abnormal types of speech in Nootka—by E. Sapir.

MEMOIR 63. *No. 6, Anthropological Series.* Noun reduplication in Comox, a Salish language of Vancouver island—by E. Sapir.

MEMOIR 46. *No. 7, Anthropological Series.* Classification of Iroquoian radicals with subjective pronominal prefixes—by C. M. Barbeau.

MEMOIR 70. *No. 8, Anthropological Series.* Family hunting territories and social life of the various Algonkian bands of the Ottawa valley—by F. G. Speck.

MEMOIR 71. *No. 9, Anthropological Series.* Myths and folk-lore of the Timiskaming Algonquin and Timagami Ojibwa—by F. G. Speck.

MEMOIR 69. *No. 57, Geological Series.* Coal fields of British Columbia—by D. B. Dowling.

MEMOIR 34. *No. 63, Geological Series.* The Devonian of southwestern Ontario—by C. R. Stauffer.

MEMOIR 73. *No. 58, Geological Series.* The Pleistocene and Recent deposits of the island of Montreal—by J. Stansfield.

MEMOIR 68. *No. 59, Geological Series.* A geological reconnaissance between Golden and Kamloops, B.C., along the line of the Canadian Pacific railway—by R. A. Daly.

MEMOIR 72. *No. 60, Geological Series.* The artesian wells of Montreal—by C. L. Cumming.

MEMOIR 74. *No. 61, Geological Series.* A list of Canadian mineral occurrences—by R. A. A. Johnston.

MEMOIR 75. *No. 10, Anthropological Series.* Decorative . of Indian tribes of Connecticut—Frank G. Speck.

MEMOIR 76. *No. 62, Geological Series.* Geology of the Cranbrook map-area—by S. J. Schofield.

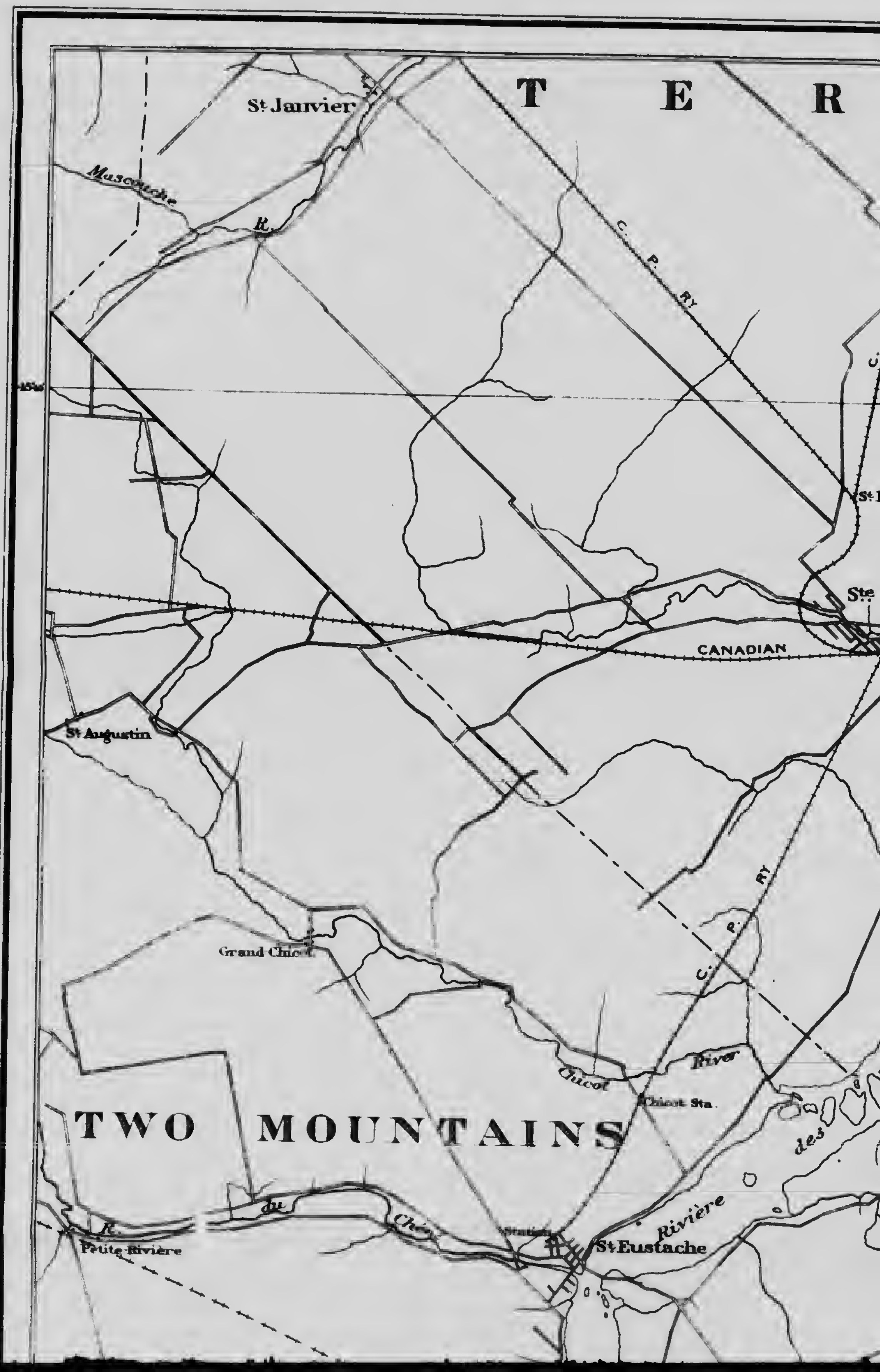
Summary Report for the calendar year 1914.

Museum Bulletin No. 10. *No. 5, Anthropological Series.* The social organization of the Winnebago Indians—by P. Radin.

Museum Bulletin No. 11. *No. 23, Geological Series.* Physiography of the Beaverdell map-area and the southern part of the Interior plateaus, B.C.—by Leopold Reinecke.

Museum Bulletin No. 12. *No. 24, Geological Series.* On Eoceratops canadensis, gen. nov., with remarks on other genera of Cretaceous horned dinosaurs—by L. M. Lambe.

Museum Bulletin No. 14. *No. 25, Geological Series.* The occurrence of Glacial drift on the Magdalen islands—by J. W. Goldthwait.



LEGEND

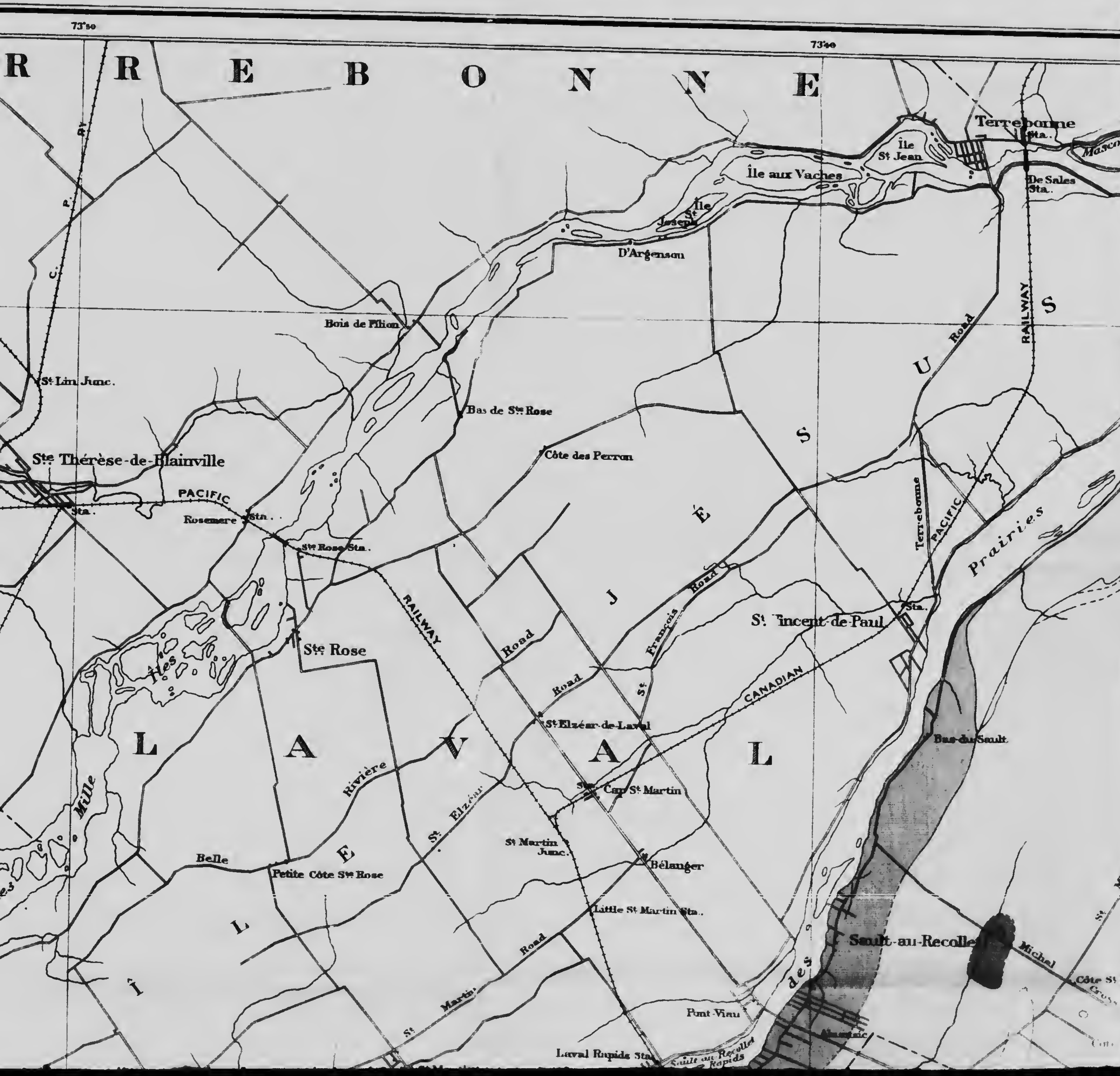
RECENT
- Marl and peat
- River sand and gravel

PLEISTOCENE
- Saxicava sand and gravel
- Leda clay
- Leda clay *sand and gravel member*
- Boulder clay

Canada
Department of Mines

HON P. E. BLONDIN, MINISTER; R. G. McCONNELL, DEPUTY MINISTER.

GEOLOGICAL SURVEY



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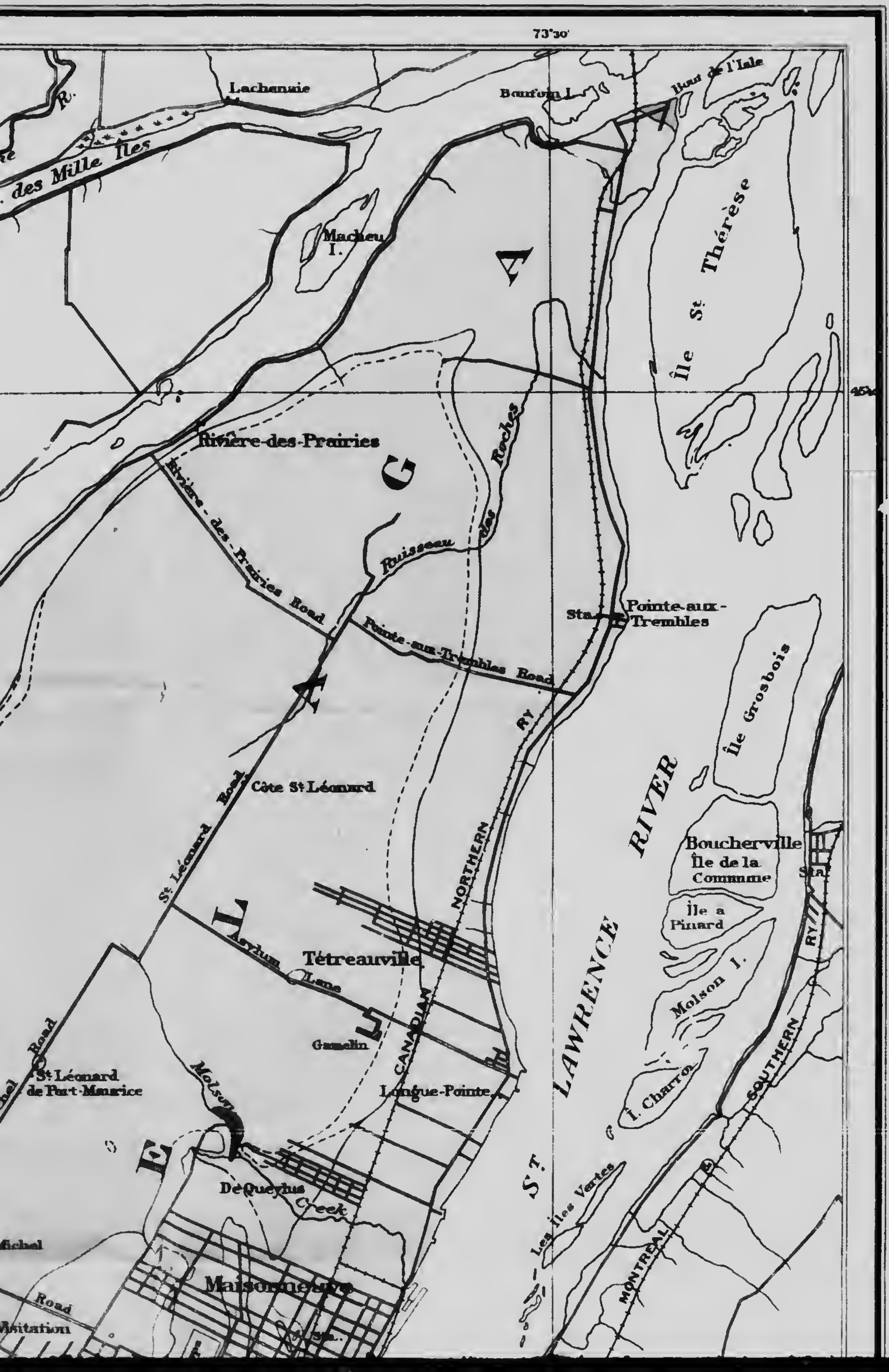
GEOLOGICAL SURVEY

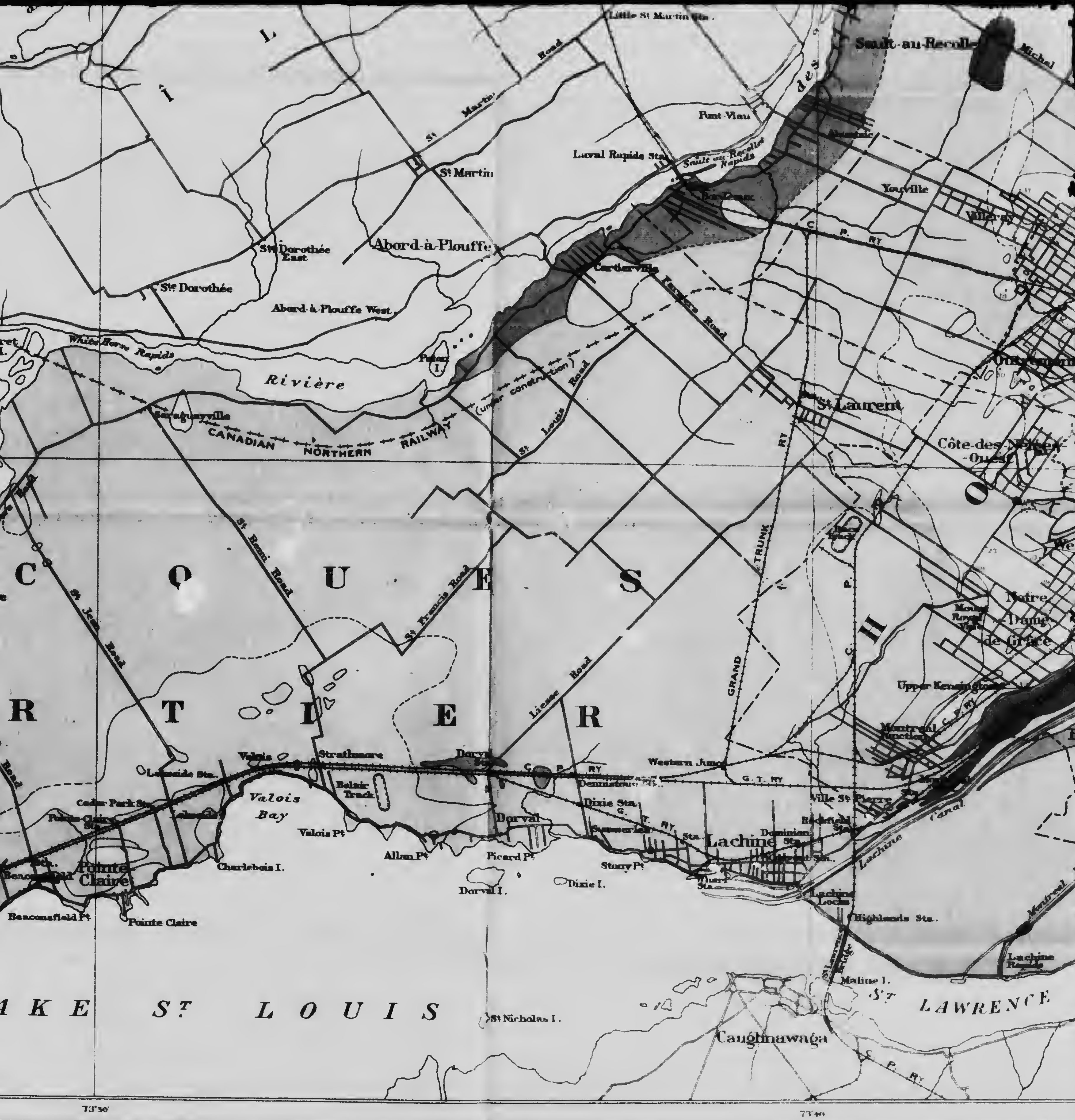
OUTLINE MAP



73°30'
Lachenaie
Bout de l'Isle
des Mille Iles
Macheu I.
Île St Thérèse
Rivière-des-Prairies
Rivière-des-Prairies Road
Ruisseau des Roches
Sta.
Pointe-aux-Trembles
Pointe-aux-Trembles Road
Île Grosbois
Côte St Léonard
St Léonard Road
Boucherville
Île de la Commune
Île a Pinard
Molson I.
Tétreauville
Asylum Lane
Gamelin
CANADIAN
NORTHERN
RY.
St Léonard de Port-Maurice
Longue-Pointe
ST LAWRENCE RIVER
I. Charron
Les Iles Vertes
Creek
MONTREAL
SOUTHERN
Maisonneuve
Road
Visitation

C.-O. Senécal, *Geographer and Chief Draughtsman.*
A. McGregor, *Draughtsman.*

To accompany Memoir by J. Stansfield.



MAP 148 A
(Issued 1916)

ISLAND OF MONTREAL, QUEBEC.

Scale of Miles

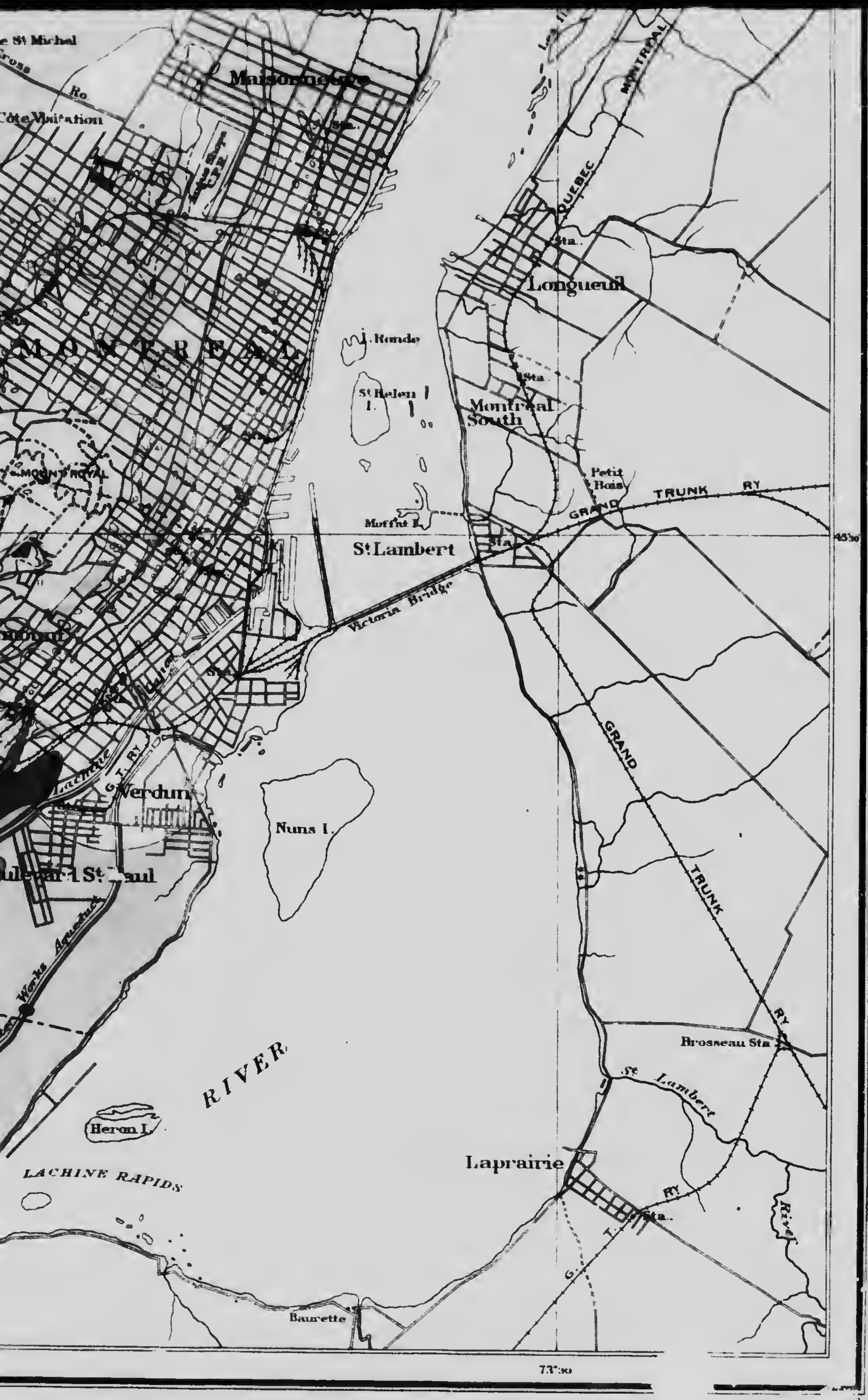
1 ½ 0 1 2 3 4 5

MAP 148 A
(Issued 1916)

ISLAND OF MONTREAL, QUEBEC.

Scale of Miles

1 ½ 0 1 2 3 4 5

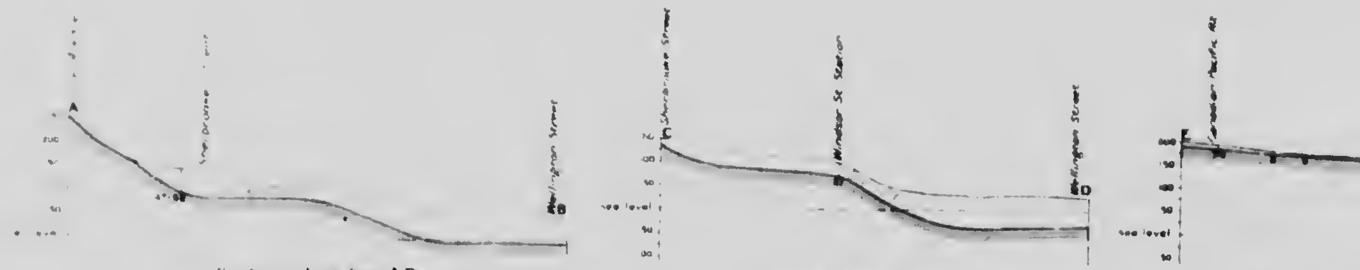


Geology by J. Stansfield, 1913

Can
Department

HON P.E. BLONDIN, MINISTER; R.G.

GEOLOGICA



Section along line AB

Section along line CD

Horizontal scale, 2½ inches to 1 mile.

LEGEND

RECENT

- Marl and peat
- River sand and gravel

PLEISTOCENE

- Saxicava sand and gravel
- Saxicava sand and gravel *inferred*
- Leda clay
- Leda clay *sand and gravel member*
- Leda clay *inferred*
- Boulder clay
- Boulder clay *(inferred)*
- Bed rock *in places with thin drift cover*
- Bed rock *inferred*

Symbols

- Geological boundary
- Geological boundary *approximate*
- Depth to bed rock in feet

Canada
artment of Mines
OLOGICAL SURVEY
Section along line EF
es to 1 mile. Vertical scale, 1 inch to 300 feet.
Section along line GH
OUTLINE MAP
TION
MAISONNEUVE
RAILWAY
Station
LONGUEUIL
ST. LAWRENCE
I. Ronde
St Helen I.
I Verte
Moffat I.
NOTE

RECENT

Marl and peat

River sand and gravel

Saxicava sand and gravel

Saxicava sand and gravel
inferred

PLEISTOCENE

Leda clay

Leda clay
sand and gravel member

Leda clay
inferred

Boulder clay

Boulder clay
inferred

Bed rock
in places with thin drift cover

Bed rock
inferred

Symbols

Geological boundary

Geological boundary
approximate

Depth to bed rock in feet

Depth to which piles have been driven

Depth reached without striking bed rock

Beach elevations determined
numbers refer to list in memoir

Surface contour in feet above sea level
(approximate)

Bed rock contour 10 feet below surface
(approximate)

Bed rock contour 30 feet below surface
(approximate)

C.O. Senécal, *Geographer and Chief Draughtsman*
A. McGregor, *Draughtsman*

To accompany Memoir by J. Stansfield.

MAP 14
(Issued 19

CITY OF MONTR

Scale of M

MAP 149A
(Issued 1916)

MONTREAL, QUEBEC.

Scale of Miles

0 1

Geology by J. Stansfield, 1913

NOTE