The Secretary then read by title the following paper:

GEOLOGY OF THE ENVIRONS OF QUEBEC, WITH MAP AND SECTIONS.

BY JULES MARCOU.

BETWEEN the vegetable mould and the subjacent rock, there is, all round Quebec, a deposit of glacial mud with scratched pebbles and boulders; and also above that glacial formation, sand deposits containing marine shells actually living in the Gulf of St. Lawrence. Near the top of Montmorency falls, 250 feet above the St. Lawrence river, that boulder formation and sand with marine shells, is well developed, and can be found even higher up, five miles northeast of Indian Lorette. I shall not refer to those superficial formations of the Quaternary period or surface geology but limit my remarks and observations to the stratigraphy of the older rocks.

MONTMORENCY.—In following the river Montmorency from the "Natural Steps" down to the bridge, the brink and the foot of the Montmorency fall, we have the following strata: At the Natural Steps, the Trenton limestone is well developed, with all its characteristics, as well lithologically, as paleontologically, absolutely like the typical Trenton limestone near Chazy village, and at Trenton falls in New York. In the dark blue, almost black limestone, stratified in beds varying from six inches to one foot in thickness, the Trenton fossils are very numerous, more especially: *Calymene Blumenbachii*, *Ceraurus pleurexanthemus*, *Illaenus Milleri*, *Trinucleus concentricus*, *Asaphus platycephalus*, *Conularia Trentonensis*, *Orthoceras*, *Murchisonia*, *Bellerophon*, *Orthis*, *Straphomena*, *Leptaena*, *Prasopora*, etc.

Coming down the river, near the road west of the bridge, and at the bridge, the limestone is not so thick as it is at the Natural Steps; and the first thirty feet lying on the quartzites and the conglomerates, is composed of thin beds, varying from half an inch to three and four inches thick only, which give to the cliffs of limestone about the bridge the appearance of a dark brown brick wall. The limestone strata in contact with the quartzites lies on the protuberances and inequalities of the quartzites, which

they follow closely as if they were moulded on them. Sometimes between the quartzite and limestone, there is a conglomerate formed mainly of fragments of quartzites cemented by calcareous matter(1), from one foot in thickness to three and even ten feet in thickness. No fossils have been found yet in that conglomerate, which seems to represent the Calcareous and Chazy formations. Then the first fifteen feet of limestone represent the Black river subdivision of the state of New York, and the last fifteen feet forming the upper part of the cliff, north of the bridge, belong to the Lower Trenton proper. The strata are horizontal. The quartzite is seen in the bed of the river, and in a small island above the bridge; the water flows over it and leaps at one bound to the foot of the precipice. The whole water-fall is made by the quartzite. Those quartzites are generally whitish-gray, stratified in beds of ten to fifteen feet thick, above the fall; at other places, they are only one to three feet of thickness. No fossils have been found in them yet; so it is impossible to classify them. Lithologically they have great similarity with the quartzites of the Potsdam sandstone of Keeseville in New York; but they may be much older. The dipping is east-south under an angle of 80 to 85 degrees, almost perpendicular; and the strike is north 45° east, to south 45° west.

At the end of a very dry summer, August 30, 1863, at my last visit to the Montmorency fall, the water of the river was very low, and I was able to explore every part of the foot of the fall. The section is represented fig. No. 1; and the fig. No. 2 is the section at the same place by Mr. Selwyn, Director of the geological survey of Canada. The water falls into a small basin formed in the quartzites. The depth of the basin is about fifteen feet, with some fragments of rounded rocks at the bottom, fallen from the top of the fall. The width of the basin is twelve feet; then there is an outcrop of quartzites about fifteen feet of thickness, the strata of quartzites varying between one foot and three feet of thickness; the stream of the river flows round and over that outcrop of quartzites; then we have a small basin of water three or four feet in width in the slates and beyond that small basin

(1) L'Abbé J. Cl. K. Laflamme, in his excellent paper, "Note sur le contact des formations palaeozoiques et archéennes de la province de Québec" (*Mem. Soc. R. Can, ada*, Section IV, 1886, pp. 43-47) gives facts, and opinions of great value; but which unhappily, were overlooked by the geological survey of Canada.

the water flows toward the St. Lawrence river over gray and black slates with thin beds of calcareous-marls interstratified now and then in the slates. No fossils have been found yet in those gray and black slates, nor in the thin beds of calcareous-marls. The slates dip at an angle of sixty degrees south-south-east. They belong to a system of strata older than the horizontal Black river and Trenton limestone of the top of the fall, and are similar and of the same age as those forming the beach of Lake Champlain west of Swanton's fall, and which I have called "Swanton slates" of the Upper Taconic system.

If we consider the plan of quartzites east of the fall, looking almost like a perpendicular wall, we see that a recession exists at the fall, and that constant washing and yearly frost, have eroded a sort of gorge. At the beginning of the modern period, just after the glacial epoch and the St. Lawrence Quarternary deposits of sand with marine shells, the Fall was exactly above the south-eastern limit of the quartzites, which are seen at the foot of the fall; and the small basin at the contact of the slate formation and the quartzites is the remains of the basin made at first by the leaping of the river. The recession seems to be of about twenty-eight to thirty feet, giving a very slow rate in forming the gorge; for we must consider that the age of the Montmorency fall is the same as the Niagara fall which had made such a long gorge during the same space of time. Notwithstanding many calculations already suggested for the recession of the Niagara fall, from near Lewiston to its actual position; suggestions which have varied from four thousand years to three millions or even more millions of years, giving a wide range of speculation as to the length of time required; it is impossible to give any close approximation. But at all events the rate of recession of the Montmorency fall is certainly very small, on account of the hard quartzite material of the fall, and of the almost perpendicular position of the quartzite strata. However the recession of the fall is a plain fact, which is clearly seen at low water. Another important fact, is that at the foot of the fall there are no traces of Black river and Trenton limestone; if any have ever fallen from above by landslides, which was very likely the case at the beginning of the existence of the fall, then all have been destroyed and washed away long before our present time.

On the left side of the fall — or eastern side — there is a small

ravine in a great V shape, which is most interesting to study, because we have there the remains of a landslide in the form of a spindle (*fuseau* in French), which has preserved from destruction a part of the Upper Trenton and Utica formations, in a sort of box situated between the almost perpendicular wall of quartzites and the gray and brown slates of the Upper Taconic. At a distance of only ten yards from the eastern part of the foot of Montmorency fall, we have the following section. Fig. No. 3.

The section begins at the top of the plateau a few yards east of the fall, then cuts the ravine perpendicularly going through the hill of slates which extend directly to the river St. Lawrence. The section is parallel to the preceding one (fig. No. 1) at a distance of only thirty or forty feet eastward.

At the top of the plateau we have fifteen feet of the Black river or Upper Trenton limestone, exactly like the fifteen feet of the section (fig. No. 1) near the bridge. The fossils are abundant; and the moulding of the thin strata of limestone over the inequalities of the heavy beds of the quartzite are conspicuous at the contact of the two rocks. Then we have the almost perpendicular wall of quartzite, with a dip of 85 degrees. At the bottom of the ravine, there is an intermittent creek, which falls from the Trenton limestone above and flows during several months of the year. When dry, the lowest rocks seen belong to the quartzite; then we have about twenty feet of blue-black Upper Trenton limestone, with a dip of only ten degrees south-south-east; then come above it sixteen feet of gray slates and two feet of blue limestone with a dip of 20 degrees; then thirty-five feet of brown and gray slates with a dip varying from thirty to forty degrees. In those seventy-three feet of limestone and slates the fossils are abundant, and according to Mr. Henry Ami, paleontologist of the Canadian geological survey, they indicate a fauna "pre-eminently Utica in facies, with an evident admixture of a few Upper Trenton species obtained from the lowest calcareous beds which crop out in the ravine." Here is the list of fossils collected and obtained by Mr. Ami: *Primitia*, *Triarthrus Becki? Calymene Blumenbachii*, *Illaenus*, *Orthis testudinaria*, *Leptaena sericea*, *Leptobolus insignis* and *Lingula*.

At the contact of the brown slates of the Utica formation, and the black slates of the Quebec city group or Swanton slates, there is great disorder and confused stratification; the dip of forty degrees passes rapidly to the vertical and is even reversed; some

of the Utica slates dipping westward instead of eastward. It is evident that the group of slates called *B* in the section, seventy-three feet thick, belongs to the Upper Trenton and Lower Utica, and has fallen into the ravine by a landslide, between the wall of quartzite on one side and the black and gray slates of the Upper Taconic on the other.

After passing the confused stratification indicated on the section figure No. 3, we come to a great thickness of black and gray slates, with now and then a few thin beds of calciferous-marls interstratified, dipping sixty degrees to the east-east-south, like all the great masses of strata of the whole Taconic system; and which form the hill extending from the ravine to the St. Lawrence river. Only close to the St. Lawrence river there is a small tongue[1] of the Upper Utica slates containing: *Triarthrus Becki*, *Endoceras proteiforme* and *Leptobolus insignis*, which is the remains of another landslide preserved above or in the Swanton slates of the Taconic system.

I have given (fig. No. 2) a section sent to me by Mr. Selwyn, Director of the geological survey, the 7th of June 1884; just at the time that he was publishing his: "Diagram section of supposed structure from Montmorency falls to the Island of Orleans," in his: "Descriptive sketch of the physical geography and geology of the Dominion of Canada," page 14, Montreal, 1884. As Dr. R. W. Ells, in his "Second report on the geology of the province of Quebec," p. 22, Montreal, 1888, says that his observations "clearly" maintain the conclusions stated by Logan and subsequently by Dr. Selwyn; it will be easy for the reader and future practical observers in the field to compare and see the difference existing among geologists on the geology of Montmorency falls.

On the western or right side of Montmorency fall, at a distance of only thirty or forty yards from the river Montmorency, there is an example of a Trenton limestone landslide. A large mass of Trenton rests on asperities of the quartzites, at an angle of eighty

[1] The expression of "tongue of Utica slates" is due to the Abbé Laflamme, Professor of Geology at the Laval University of Quebec. It is a happy word, which expresses in the most satisfactory way a phenomenon constantly met with in the province of Quebec, near the contact of the Champlain system with the Upper Taconic strata, brought about by landslides due to great erosions and denudations. *Ann. Report, Geol. Surv. Canada*, vol. II, new series, 1886, p. 37, A, Montreal, 1887.

degrees — almost perpendicular. That landslide must be quite recent when compared with the landslide of the eastern ravine previously described and given in fig. No. 3.

CHARLEBOURG. — I have already given the section of the road from the city of Quebec to Charlebourg ("The Taconic of Georgia and the report on the geology of Vermont"; *Mem. Boston Soc. Nat. History*, vol. IV, plate 13, 1888) showing local folding and small local faults. From Charles river to the Trèsplat, there is a great mass of slates, dipping south-easterly at an angle of forty to sixty degrees, of a thickness of at least 2,500 feet, more probably 3,000 feet, belonging to the Swanton slates of the Upper Taconic. I did not find any fossil during my researches; but the stratigraphic position of those slates above the Point-Lévis great group, and their lithological structure, showed them to be the equivalent of the Swanton slates of Vermont.

The little plateau of the Trèsplat above the village of Charlebourg is formed wholly of horizontal strata of the Black river limestone or Lower Trenton, lying in discordance of stratification over the Swanton or Quebec-city slates. Lately Messrs. Giroux and Ami of the geological survey of Canada have found, between Charlebourg church and Trèsplat, a tongue of Utica slates containing: *Triarthrus Becki*, *Primitia*, *Bellerophon* and *Strophomena*. That tongue of Utica slates seems to extend one mile eastward, as far as a small brook. It is another example of landslide of the bituminous slates of the Utica group, brought about by a process of denundation and destruction, followed by a slide-down, with the usual result of a tongue of Utica, inclosed in or covering the Upper Taconic slates. ("Second report on the geology of a portion of the province of Quebec," by R. W. Ells, p. 20 K, in *Ann. Report Geol. Surv. Canada*, 1887, Montreal, 1888.)

INDIAN LORETTE. — The bed of the Charles river at the fall and down the rapids is occupied entirely by the same quartzite as at Montmorency fall and river; only the strata are not so thick being only half a foot, or one foot — very seldom three or four feet of thickness. On the right side of the river (fig. No. 4) and consequently westward of the village, overlying the quartzites, there is a deposit of fifteen feet of calcareous sandstone, reddish and very finely grained, representing the Calciferous and Chazy, which forms a sort of gigantic step between the perpendicular wall of Black river–Trenton limestone and the gorge of quartzite

of the river bed. No fossils have been found yet in either the quartzite or the fifteen feet of reddish calcareous-sandstone. Above the reddish Calciferous-Chazy there is a perfect vertical wall, fifty feet high, formed of beds of Black river and Lower Trenton limestone, one foot thick, instead of being one or three inches thick as they are at Montmorency bridge.

At Indian Lorette, just close by the bridge, the strata of the Champlain system are almost horizontal, with a very slight inclination toward the south-east. But in descending the rapids of the Charles river, the inclination increases rapidly, and from a dip of ten degrees it passes to twenty and thirty degrees, and finally it reaches the vertical. We have there good examples of landslides by erosion of the Champlain systems strata over the quartzites. I did not see on what rocks the vertical beds of the Trenton limestone lies. On the interrupted and fragmentary section (fig. No. 4) I have indicated the quartzites; but I am not sure; the Taconic slates so common and which form the whole undulated plain in which the Charles river flows, may reach as far up as the vertical Trenton strata are. It is a question to be solved by exact and minute observations in the field.

Messrs. Ami and Giroux of the geographical survey of Canada have published the following list of fossils, collected by them at the foot of the Indian Lorette fall: *Illaenus Milleri*, *Trinucleus concentricus*, *Dalmanites callicephalus*, *Encrinurus vigilans*, *Calymene Blumenbachii*, *Ceraurus pleurexanthemus*, *Asaphus platycephalus*, *Beyrichia*, *Primitia*, *Endoceras proteiforme*, *Lituites undatus*, *Ambonychia*, *Pterinea Trentonensis*, *Ctenodonta dubia*, *Theca*, *Conularia Trentonensis*, *Bellerophon bilobatus*, *Bucania punctifrons*, *Atrypa hemispherica*, *Orthis testudinaria*, *Strophomena alternata*, *Leptaena sericea*, *Lingula*, *Discina*, *Polyzoa*, *Pachydictya*, and *Prasopora lycoperdon*. As they say, a part of those fossils have a Black river facies in the lowest portion of the strata; and the rest indicate the Lower Trenton limestone (*Loc. cit.* pp. 19-20.)

Quebec-city. — All the lower part of the valley of the St. Charles river, is occupied by the Swanton slates of the Upper Taconic system. The gray and black slates are seen in many places on the roads from Quebec to Indian Lorette, to Charlebourg and to Beauport, with local folds well marked on the roads to Lorette and to Charlebourg, and also on the edge of the St. Lawrence river at La Canardière.

The city of Quebec is built at the extremity of a sort of promontory, extending from the mouth of the Charles river to Cape Rouge (pronounced *Carouge* by the French Canadians). This promontory is capped by a sort of plateau, more or less accidented by small hills, which begin behind the citadel and extend to Ste. Foye, St. Albans and Cape Rouge, bounded on the south by escarpments like almost perpendicular cliffs on the St. Lawrence river, and on the north by another great escarpment called "Côte Ste. Geneviève," "Côte de la Négresse," Côte Sauvageau," etc. The whole is an elongated mountain formed entirely by the Upper Taconic strata arranged in a fan-like structure (called *structure en éventail* by the French and Swiss geologists) very common in the Alps. It is the result of some strong lateral pressure, made upon rocks mainly slaty, but containing now and then lenticular masses of magnesian limestone, limited bands or spindles (*fuseaux* in French) of pudding limestone, conglomerate and even of sandstone, which being strongly squeezed north and south, was forced into folds, with a quantity of small, very local faults (called *faillottes* by French geologists). All the folds strike more or less east-westward with a deviation toward the north and south, just like the course of the St. Lawrence river, which very likely has followed some of the local folds in digging its bed into the slaty Taconic strata.

The celebrated citadel of Quebec is built on the very top of the most important and largest of those folds; and if looked at from the other side of the St. Lawrence, or from the middle of the stream, we see (fig. No. 5) a splendid arched fold with a long rise of the strata at the back of Champlain street, recalling the arched fold of the citadel of Besançon in Franche-comté (France).

As I have said previously, the great masses of rocks are slates, varying in color from gray to blue, brown, black, red and green. But the slates contain inclosed beds, all more or less lenticular and limited in extent, of marly limestone, magnesian limestone very hard and almost sub-crystalline, pudding limestone, true conglomerate, and some small lenticular masses of magnesian limestone varying in size from an egg to a diameter of one or more yards. For instance in ascending the rue de la Montagne, just in the perpendicular cliff of the black slates, under the Seminary garden, a lenticular block of whitish magnesian limestone,

one yard in diameter, is seen (1863) at a height of about thirty-five feet above the street, inclosed in the slates, just as if it had been placed there in a sort of niche, or framed into the wall of black slates. At first it looks like a limestone boulder perched in a slaty cavity.

Between the foot of the escarpment at the "Côte de la Négresse" to the "rue Champlain" at the north-west corner of the citadel, the strata has a thickness of at least 3,000 feet, which added to the 2,500 or 3,000 feet of slates existing between the St. Charles river and Trèsplat at Charlebourg, gives a total of 6,000 feet, at least, for the Upper Taconic, in the city of Quebec and its vicinity. The fossils are very scarce. It is not like the Champlain system at Montmorency, Beauport, Trèsplat of Charlebourg, Indian Lorette and St. Ambroise, where fossils are very abundant, and are found without any interruption in following the strata horizontally. After many years of researches, only five very limited spots in the plain and "Côte d' Abraham" have been found, containing a few fossils. Messrs. Ami and Giroux who made the discovery of those fossils, give the following list (See, on the geographical map accompanying this paper, the five spots, marked by a small cross.) Between the Grand allée and the Drill shed, eight graptolites; between St. John market and St. Patrick street nine graptolites, three *Lingula* undescribed and special to those strata, *Obolella*, *Acrothale*, *Stricklandinia*, n. sp., *Orthis*, *Leptaena* n. sp. *Leptaena sericea? Cyrtolites*, *Illaenus* n. sp., *Ampyx*, n. sp. *Trinucleus*, n. sp., *Cheirurus? Asaphus?* n. sp., *Bathyurus? Hydrocephalus* or a new genus, *Cyphaspis?* n. sp., *Beyrichia?* and *Primitia*, all new species or doubtful ones. At "Côte d' Abraham" several monticuliporids, an *Orthis*, a *Leptaena sericea*, and portions of pleura of a species of *Asaphus?* (*Loc. cit.* pp. 77-80, K).

Such an imperfect and limited fauna does not allow the conclusion given by the geographical survey of Canada, that the Quebec citadel series of strata belongs to the Trenton-Utica and more specially the lower portion of the Utica slates; but simply that we have there primordial forms mixed with very few second fauna forms. *Lingula*, *Obolella*, *Acrothele*, *Orthis*, *Bathyurus*, *Primitia*, are all characteristic forms of the "Lingula flags" of Wales and of the Phillipsburgh and Pointe-Lévis group of Canada and Vermont. As to the *Leptaena*, *Illaenus*, *Ampyx*, *Trinucleus*, *Cheir-*

urus? and *Asaphus?* they all belong to new species, not found anywhere in the typical Champlain system of North America or of Europe, and the only inference which we can safely draw from their presence in the Upper Taconic strata, is, that those genera made their apparition in the Nevado-Canadian sea sooner than in the Acadio-Russian ocean, that they migrated from the western sea into the eastern sea, and that we have there another example of the apparition of the prophetic types and colonies of Barrande during the primordial period.

Besides we have a striking example of the co-existence in Europe of the trilobitic genera *Asaphus* and *Cheirurus*, with the *Olenus*, *Agnostus*, and *Conocephalites* at Hoff in Bavaria, just as we have at Quebec-city, at Pointe-Lévis, at Phillipsburgh and many other places in the states of Vermont and New York, the trilolites genera *Asaphus*, *Cheirurus*, *Ampyx*, *Illaenus*, *Trinucleus*, which have co existed with *Conocephalites*, *Agnostus*, *Dikelocephalus*, and *Bathyurus*. Barrande, Linnarson and others well qualified to express an opinion on the primordial fauna, have no hesitation in placing the strata of Hoff in the Upper Taconic of Europe, and not in the second fauna.

If the normal and original Champlain system, as it exists at Trenton falls and Chazy village, was at a great distance from the citadel of Quebec, say 5,000 or 6,000 miles, some hesitation, as regards the synchronizing of the strata of the city of Quebec, may be understood, to a certain extent, although the Champlain system never shows in the Lake Champlain area and around Montreal and Ottawa, a mixture of primordial forms, such as: *Bathyurus*, *Dikelocephalus*, and *Conocephalites*. But in the vicinity of Quebec, we possess the normal and typical Champlain system, at a distance less than a cannon shot — only two miles; and if we reconstruct the deposits as they existed at the time of the end of the Champlain period, before any erosion or denudation took place, when the sea had just retired, then we see that the Champlain strata were deposited over a great part of the Upper Taconic, and are consequently younger than the Quebec-city and the Point Lévis rocks, which were then already a *terra firma* and formed in their prolongation under water the beds of the Champlain sea in the area of Quebec and its environs.

I have tried to reconstruct the deposits, as they were at the end of the Champlain period, in a "Section from Montmorency

to the mouths of Beauport and St. Charles rivers across the city and citadel of Quebec to the western foot of the citadel." (Fig. No. 6.) The part of the section drawn with full lines is the actual section as seen from the "Natural Steps" above Montmorency fall, to the foot of the fall, and then following closely on the edge of the St. Lawrence river, at low tide, in passing across Beauport beach and la Canardiére, to the old rampart of Quebec, the citadel and Champlain street, to the St. Lawrence river. And the pointed lines indicate the outlines of the deposits as they existed before any denudation, erosion and landslide took place; as well as the *terra firma* of the Laurentine Mountains on the north, and the Champlain continent on the south; the last shore being formed by a plateau composed entirely of Taconic strata, which has been upheaved and cleared out of water by the great break and total overturn of the whole Taconic system at the end of the deposits of the Quebec-city and Swanton states.

The stratigraphy (strikes, dipping, thickness, succession and superposition), the lithology and the paleontology (species, habitat and geographical distribution) of the great slaty system called Taconic by Dr. Emmons, are so completely different from those of all the other palaeozoic systems, that it is materially impossible to confound its divisions and great groups with any of the Champlain (primitive Cambrian of Sedgwick), of the Silurian (primitive Upper Silurian of Murchison), of the Devonian and of the Carboniferous. The sporadic character of habitat of fossils in the Taconic system, is general everywhere, and can be used safely to indicate the existence of that system.

The attempt of the geological survey of Canada to synchronise and correlate the Quebec-city rocks with the Chazy, or the Lower Trenton, or the Upper Trenton, or the Utica slates; to consider the enormous mass of slates which form the entire valley of the St. Charles river between Quebec-city and the foot of Montmorency fall as the equivalent of the Lorraine shales of the State of New York and of the vicinity of Ottawa; to identify the Pointe-Lévis group with the Calciferous of Chazy village, Argenteuil and Ottawa (at Gatineau river); is made against all sound principles used in practical geology. Paleontology after being used first wrongly in transferring the primordial fauna above the second fauna at Georgia (Vermont), at Pointe-Lévis, and at Bald Mountain by the paleontologist of the geological survey of the State

of New York, has been the tool constantly used by unskillful hands to classify strata absolutely different in every respect from those with which they have been identified.

Few paleontologists are able to deal with stratigraphy and lithology. I shall name only a few of the dead, such as: Edward Forbes, Barrande, Alcide d'Orbigny, Quenstedt, von Buch, Oppel, Newmayr, Linnarson, E. Emmons, Conrad, de Verneuil, David son, Salter, etc. But unhappily many paleontologists, not so skilful as those just named, have tried to classify strata with either incomplete data, or with incorrect determination of species, of genera and even of family; and without hesitation they have given and used classifications of strata incorrect and at complete variance with the facts as they exist *in situ*. Of course the rocks are there plainly exposed to view, and observers can go any day and see for themselves. Obstruction cannot last very long, and first-rate paleontologists, although rare, are sure one day or another to take in hand all the questions at variance, and to see that paleontology properly understood and used, is in complete harmony with the result arrived at by stratigraphists and practical geologists.

A quotation taken from "Life and letters of A. Sedgwick," by Clark and Hughes, vol. ii, pp. 397-398, Cambridge, 1890, applies most fittingly to the case. It reads as follows: " . . . No good classification either of subdivisions or systems, or of subordinate formations, ever can be attempted without a previous determination of the physical groups. The study of fossils, based on ascertained physical groups, may produce, and often does produce, some modification of our lines of demarcation; but the *evidence of sections must ever remain as the primary basis of geology*. When a system has been well made out, and its groups of fossils determined, we may then make use of comparative groups of fossils freely, and with very small risk of mistake. *But to begin with fossils, before the physical groups are determined, and through them to establish the nomenclature of a system, would be to invert the whole logic of geology, and could produce nothing but confusion and incongruity of language.*" The italics are mine. Dr. Emmons and the present writer have followed strictly Sedgwick's rules, while their opponents on the contrary have "inverted the whole logic of geology," with the constant result of "confusion and incongruity of language."

POINTE-LÉVIS.—On the southern side of the St. Lawrence river, opposite Quebec-city, the Taconic strata occupy the whole area as far up the river as St. Nicholas, twelve miles above Pointe-Lévis, where a tongue of Utica slates has been inclosed in and over the Taconic slates, by a landslide. Twenty-six years ago, I published a detailed paper on the geology of Pointe-Lévis, entitled: "Notice sur les gisements des lentilles trilobitifères taconiques de la Pointe-Lévis, au Canada." (*Bull. Soc. géol. France*, vol. XXI, p. 236, Avril 1864); accompanied by a carefully made plan of the outcrops of fosiliferous magnesian limestone, and by a section taken from the main street of Lévis at the Croix-de-Tempérance in a south-easterly direction.

As a lithological confusion in regard to conglomerate has been maintained until now by the geological survey of Canada, I shall give another section (fig. No. 7) taken a little farther east than the one published in 1864, from the shoal, at low tide of the St. Lawrence river, to the church of St. Joseph and the top of the Redoubt or Notaire Gay's quarry.[1]

Explanation of the section fig. No. 7:) Close by the river there is a pudding-limestone, heavily bedded, formed of a matrix of blue limestone containing, disseminated irregularly, a certain number of large pebbles of another grayish limestone. No fossils had been found yet in either the matrix or the pebbles. The strata dip south-south-east, at an angle of sixty degrees, and their strike is east-east-north, to west-west-south, pointing directly toward the southern part of the citadel of Quebec. Those blue-pudding limestones of the upper part of Pointe-Lévis group can be seen in

[1] During the last Franco-English war, in 1759, a redoubt was roughly built there, on account of its commanding position over the St. Lawrence river and the country around. After being taken by the English, it was promptly dismantled, and nothing remains of it, except the name of the "Redoute" kept among the French inhabitants. The Notaire Gay, proprietor of the place, came to see me, when I was working the geology of that part of Pointe-Lévis, and gave these details, as well as the name of the road to Arlaka, having the kindness to write himself the name Arlaka, which resembles Arthabaska, another Indian name. The geological survey of Canada have lately called in question both names; saying that I have styled the mass of limestone found on the Arlaka road by the name of the "Redoubte," spelling Harlaka with an *h*. It is well known that a certain contempt always exists for the French-Canadian called "Cannuck," and their noble defence of their country against the British army. But notwithstanding the stricture of the Canadian geological survey the facts are that above the St. Joseph's church, the principal knob of limestone is called the "Redoute," and the old Indian village of Arlaka is spelled without an *h*, by the French inhabitants, the best judges in the question.

several parts of Champlain street at Quebec, and form with the slates in which they are enclosed almost one-third of the mountain on which the Chateau St. Louis, the old city of Quebec and the citadel are built, as it is marked on the section fig. No. 6. It is probable that the part of the bed of the St. Lawrence, between Pointe-Lévis shoal and the "Sault du Matelot" at Quebec, is formed entirely of those pudding limestones interstratified with slates; the slates, as usual in the Taconic system, being much thicker and more frequent than the limestones.

South of and close by the church of St. Joseph, there is a small lenticular mass of magnesian limestone, fifteen feet thick and very limited, without fossils. Then come twenty feet of slates, dipping at an angle of sixty degrees. Above it we meet the elongated lenticular mass of true conglomerate, which I have called outcrop of the "Croix de Tempérance," in my paper of 1864—the only conglomerate in the full sense of the word existing at Pointe-Lévis. Its thickness at the section fig. No. 7 is only fifteen feet; some thin beds of magnesian limestone and gray slates are interstratified in forms of spindle (*fuseau*). No fossils have been found in either the pebbles or in the interstratified magnesian limestone and slates. In 1863, a house, called "Letellier house," built on that true conglomerate, was a prominent landmark between the Main street of Pointe-Lévis and the Redoubt. From that house a small plateau extends toward the foot of the Redoubt, and at about mid-way, inclosed in slates, there is an outcrop of magnesian limestone with fossils, which is a prolongation of the lenticular mass of the Redoubt, after its sharp turn, a few yards eastward opposite the second Chapelle. Near the northern foot of the Redoubt the slates dip more and more; and then the heavy bedding rocks, indistinctly stratified, as they always are in the lenticular masses of the magnesian limestone of the Taconic, dip south-east at an angle of seventy-five degrees, passing rapidly to the vertical, at the top of the Redoubt; then dipping in the opposite direction north-westward under an angle of eighty-five degrees. The slates at the southern foot of the Redoubt dip at an angle of eighty-six degrees toward the northwest; and finally the conglomerate band of the "Croix de Tempèrance" dips also north-westward. The reversion of the dip of the strata at the Redoubt is due to a local fold, and the difference of thickness of the slates, conglomerate and magnesian limestone-

are due to pressure of the slates and to enlargement of the lenticular masses, so often seen in all the lenticular masses of the Taconic system.

Until my first exploration and study at Pointe-Lévis in 1861, no fossils had been found at the Redoubt, where I collected a good primordial fauna such as: *Arionellus*, *Dikelocephalus*, *Conocephalites*, *Menocephalus*, *Leptaena*, *Metaptoma* and *Cystidae*. The geological survey of Canada, having sent one of its members to see how I made observations in the environs of Quebec, was advised of my discovery of fossils at the Redoubt, and of its importance as well stratigraphically as paleontologically. I shall only repeat what I have already said in 1864: That the lenticular masses found in the three folds of Pointe-Lévis are simply the result of a local accident of folding, limited to one and a half mile square. The magnesian limestone there contains a primordial fauna, indicating the lower porton of the Supra-primordial fauna or Upper Taconic. That the outcrop of Pointe-Lévis belongs to the same horizon as the Phillipsburgh group, only it is a little below or more exactly the inferior part of that horizon. That the fossiliferous lenticular masses, called by me "Redoute," "Milieu," "Devine" and "Colline Paroisiale" are not formed by a "Limestone conglomerate," as it has been erroneously called by some geologists, but by a magnesian limestone, perfectly homogeneous, without any boulders or pebbles of any sort; and that the fossils are disseminated in every part of each lenticular mass, either in nests or sporadic. That the fossils with forms of the second fauna, are only "prophetic types," and that we have there an example of what Barrande has called his "doctrine des colonies."

The true conglomerate of the lenticular mass called the "Croix de Tempérance" does not contain any fossils, and the blue pudding limestone of the most northern part of Pointe Lévis, close by the shoal of the St. Lawrence, and in the village, does not contain any fossils, in either the matrix or the pebbles.

La Chaudière's fall.—In following the road from Victoria hotel at Lévis to the river des Etchemins and La Chaudière's fall, just when reaching the mouth of the river Etchemin in the river St. Lawrence, the slates present flows of diorite or more exactly diabase—"old basalt"—which are more or less intercalated and even stratified into the slates. The whole country between the

river Etchemin and La Chaudière's fall shows such outcrops of diabase protruding from the red, green, brown and black slates. Near the Chaudière's fall these diabases are extremely phonolitic, ringing under the hammer like bells. Those dyke-beds (*filons-couches* as they are called in French) intercalated into the grauwakes or Taconic slates, recall the same phenomenon of dykes and intercalated beds of diabase (*porphyrites* and *Kersanton*) which exist between the "Rade de Brest" and the "Douarnenez" bay in Britany (France). It seems that the eruption of those phonolitic diabases—a very remarkable example of ancient volcanos during the Taconic period—prevented the existence of marine animals in the area directly under their actions, for no fossils have been found there yet. Near to it, however, at the crossing of the Railroad above Chaudière's fall, a small brachiopoda, called *Obolella preciosa*, has been found. The same fossil has been collected by the members of the geological survey of Canada on the shores of the St. Lawrence river east of Arlaka junction, near the Hotel Victoria at Lévis and at Pointe-à-Pizeau. The slates containing the *Obolella preciosa*, with some *graptolites*, lay directly below the Pointe-Lévis group and are placed a little above the *Elliptocephalus* (*olenellus*) *Thompsoni* beds found by the geological survey of Canada near Beaumont. The horizon of the *Obolella preciosa* can be taken as the approximate extreme limit between the Upper and Middle Taconic; and the groups of the "Georgia slates" containing the *Elliptocephalus Thompsoni* extend from Bic-Harbor to above Beaumont, east of Pointe-Lévis. It is composed of the belt of slates, which runs south of the local fold of Pointe-Lévis, reaching the St. Lawrence again at the western extremity of the fold near the Old Victoria hotel; cross the St. Lawrence to near the Pointe-à-Pizeau, following for a very short distance up the shore toward Cape Rouge. The diabasic slates of the area between the mouth of Etchemin and Chaudière rivers and Chaudière's fall belong to that division of the Middle Taconic or Georgia groups.

I was unable to find a single fossil in the red slates spotted with green and the gray reddish sandstone with ripple-marks, which form the masses of strata of the Chaudière's fall. At my first visit there in 1849, I was much struck by the exact similarity of the rocks with those existing at the fall of the river Montreal near the south-west shore of Lake Superior; and I have no doubt

that both falls are made among slates of the Middle Taconic system; just as Kakabeka's fall on the river Ministiquia, north-west of Lake Superior, has been referred by me to the black slates of the Lower Taconic.

Conclusions.—We can assume the following facts as well established for the geology of the vicinity of Quebec: Two different systems of Lower Paleozoic rocks are found there. 1st, the Champlain system, almost horizontal with remains of landslides, near the actual edge of the system, which has left fragments or spindles (*fuseaux*) of Trenton limestone in ravines or perched on asperities of quartzites, and tongues of Utica slates lying over Taconic slates. Denudation and erosion hasr educed the Champlain system of the vicinity of Quebec to very narrow limits, as well horizontally as vertically. 2d, the Taconic system is always strongly dislocated, with a general dip south-eastward, under an angle of an average of sixty degrees. As the whole system has been overturned, and is mainly formed of an enormous mass of slates, at least 20,000 feet thick, there is in such a mass many small faults (*faillotes*) which do not affect by any means the whole system, or any portion of it; and also many local folds, the most conspicuous being Pointe-Lévis and the Citadel of Quebec. But nowhere do those small faults or local folds repeat on a great scale the different groups of the Upper, Middle and Lower Taconic.

The upper part of the Taconic system, 6,000 feet thick, is formed by the strata which cover the whole ground from the foot of Montmorency fall to near Pointe-à-Pizeau, Victoria hotel at Lévis, and half-way between Beaumont and Pointe-Lévis. In that great mass of 6,000 feet of strata, two great groups may be made for convenience. The first upper 3,000 feet are called "Quebec-city group" or "Swanton slates" of Vermont. In it are sporadic apparitions of forms of fossils of the second fauna mixed with supra-primordial forms, at only three or four places in the vicinity of the Plain of Abraham, as at Highgate-spring in Vermont. But generally the Quebec-city group or Swanton slate is bare of fossils.

The lower 3,000 feet of the Upper Taconic are well developed at Pointe-Lévis, under the Chateau St. Louis and the upper portion of the old town of Quebec and under the citadel, extending along the northern shore of the St. Lawrence as far as Mount

Herman cemetery near Pointe-à-Pizeau. Fossils are found in some lenticular masses of magnesian limestone at Pointe-Lévis, and are distributed in a sporadic way, just like at Phillipsburgh, with colonies of forms of the second fauna mixed among supra-primordial fossils.

Both great groups are characterized by the genera of trilobites called *Dikelocepalus* and *Bathyurus*, which have never been found in the typical Champlain system of the New York geological survey. The Upper Taconic correspond exactly to the *Olenus* zone of Scandinavia and to the Ffestiniog, Tremadoc, and Arenig or Skiddau groups of Segwick in North Wales.

Below the Upper Taconic the slates are characterized by a fauna entirely primordial, without any mixture of forms recalling the second fauna. The principal fossils found in the vicinity of Quebec are : *Obolella pretiosa* and *Elliptocephalus* (*olenellus*) *Thompsoni*. The thickness of the Middle Taconic cannot be given even approximately, because we do not know yet the Lower Taconic in that region ; but it must be several thousand feet thick. Old volcanic eruptions have left remains in diabase dikes and flows, between Etchemin and La Chaudière rivers, in the Middle Taconic group of slates ; but so far the history of those volcanos, which have left such conspicuous land-marks at Bel-Oeil, is entirely to be written, for neither the geological survey of Canada, nor private observers, have yet touched that important part of the Lower paleozoic eruptive rocks.

The quartzites of Montmorency and Indian Lorette are of an unknown age.

In such a mass of broken slates as those of the vicinity of Quebec, it is extremely difficult to use the lithologic character, in order to make subdivisions and divisions ; but I have no doubt that, if a geologist inhabiting Quebec or Pointe-Lévis devotes fifteen or twenty years of constant work to them, that he will succeed in giving a rational and clear classification of every foot of strata. It is a work of patience and good practical geology.

Explanation of the Geological Map. — During my first visit at Quebec, in September 1849, I made a first rough sketch of a geological map, and a general section from Montmorency to Chaudière's fall ; giving a copy of both to my friend, the late François Xavier Garneau, the historian of Canada, who accompanied me to every locality. Garneau was specially anxious to

know if there was any peculiar geological fact at Wolfe's cove and Wolfe's field, in explanation of the choosing of that special locality of the north shore of the St. Lawrence river for disembarking the British army. After looking carefully, I did not see any fault, or any change in the lithological character of the slates. Denudation and erosion were the only factors in allowing a more easy ascent of the cliff at that place. Lately Dr. Ells in his Report (*Loc. cit.* p. 44 K) says that he found "a profound fault," a new term, never used in geology before, and which is not explained.

In 1861, '62 and '63, I finished my first sketch of 1849; and if I did not publish sooner my notes with geological map and sections, it was because I thought that after the publication of my letter to Barrande in 1862, and my paper on Pointe-Lévis in 1864, I had given sufficient explanations of the geology of the environs of Quebec, and a classification of strata so clear and well justified by plain facts in the field that it was almost useless to go any farther on my part, leaving the field to local geologists and the geological survey of Canada. But the publication of the Report of Dr. Ells in 1890, and his paper of April 1890, in the *Bulletin Geol. Soc. America*, VOL. I, pp. 453–468, with a geological map of the vicinity of Quebec, present the geology of the region in such a shape, and with such classification and dynamic phenomenon of great faults, entirely different from the result arrived at by my researches, that I am justified in publishing my observations at this late date, so many years after making them.

The only additions made to my map are due to discoveries of Utica fossils, on the edge of the St. Lawrence river at the mouth of Montmorency river, and at two places near Charlebourg's church, by the geological survey of Canada. I have marked by a cross the places where Taconic fossils have been found, always in a sporadic condition, by both the geological survey of Canada and myself.

Finally I must say, that the outcrops of the diabasic flows and eruptions among the slates of the Middle Taconic, in the Etchemin and Chaudière rivers area, were not surveyed carefully and want to be looked a-new on a map of large scale. On my map they must be taken as an expression of a general fact existing in that area, and not as mathematically exact, as regards precision in their location.

Bibliography of the Geology and Paleontology of the Environs of Quebec. [1]

1827—Bigsby (J. T.).—The true initials are J. J.—On the geology of Quebec and its vicinity (*Proceed. Geol. Soc. London*, vol. I, p. 37) The quartzite of Montmorency fall is called gneiss, and the limestone of Montmorency and Beauport is referred to the carboniferous limestone of English geologists,

1829—Baddeley (F. F.).—On the geognosy of a part of the Saguenay country (*Trans. Lit. and Hist. Soc. Quebec*, vol. I, p. 79). With a sketch geological map from Cape Rouge and Quebec to Lake St. John. The limestone of Montmorency is referred, with doubt, to the carboniferous.

1829—Green (William).—Notes on the country in the neighborhood of the falls of Montmorency (*Trans. Lit. and Hist. Soc. Quebec*, vol. I, p. 181). With a plate containing seven geological sections.

1841—Emmons (Ebenezer).—Geology of Montmorenci (*Amer. Magazine* Nov.; reprinted in *Amer. Geologist*, Aug. 1888, vol. II, p. 94.). The Beauport limestone is referred to the Trenton limestone; the sandstone and conglomorate, fifteen to twenty feet thick, directly below the Trenton is referred to the Potsdam, and the quartzite of the fall is called gneiss. Dr. Emmons has reproduced his section of the falls of Montmorency, at p. 138 of his *Agriculture of New York*, vol. I, 1846; and also at p. 55 of his *Manual of Geology*, first and second editions, 1859–60.

1845—Bayfield (H. W.).—On the junction of the transition and primary rocks of Canada and Labrador (*Quart. Jrn. Geol. Soc. London*, vol. I, p. 450). The limestone of Beauport and Indian Lorrette is referred to the Silurian.

1845—Lyell (Charles).—Travels in North America, in the years 1841–42, vol. II, p. 108. The quartzite of Montmorency is referred to the gneiss, and are regarded as "truly primary."

1845—Logan (W. E.).—Message de son excellence le gouverneur général, avec Rapports sur une exploration géologique de la province de Canada, présenté à la chambre, le 27 Janvier, 1845, Montreal. The first report, called: "Remarques sur le mode ou la manière de procéder pour faire une exploration géologique de la province," is dated, 6 Dec. 1842. At p. 20 of this preliminary report, the author says that he does not know the exact place in the stratigraphic scale of the folded rocks at Pointe-Lévis, but he inclines to regard them as *below* the horizontal strata of the St. Lawrence limestone (that is to say the limestone of Beauport and Montmorency). But acting under the influence of advices received, shortly after, from

[1] The order is chronological even in each year, when several papers were issued during the same year.

the Paleontologist of the Geological Survey of the State of New York and the Geologist of the State of Pennyslvania, he added, in, 1845, a foot-note, in which he retracted his first opinion of 1842, saying that the rocks of Pointe-Lévis are *above* the St. Lawrence limestone (Trenton limestone).

1853.—Bigsby (J. J.).—On the geology of Quebec and its environs (*Quart. Jrn. Geol. Soc. London*. vol. IX, p. 82). With a "Geological map of the vicinity of Quebec," on which all the strata of Quebec and Pointe-Lévis are placed *above* the Trenton limestone, as belonging to the Hudson river group.

1854—Logan (W. E.)—Geol. Surv. Canada. Report of Progress for the year 1852–53. Quebec. Geology of the north side of the St. Lawrence, between Montreal and Cape Tourmente below Quebec; pp. 34–36.

1855.—Logan (W. E.) et Sterry-Hunt (T.).—Esquisse géologique du Canada, Paris, pp. 49–52. With a general: "Carte géologique du Canada," par W. E. Logan. The hills around Quebec and Pointe-Lévis are referred to the Hudson river group and the Oneida conglomerate. On the map, Pointe-Lèvis and a part of Quebec hills are colored as Onondaga gypseous limestone.

1858.—Hall (James).—Descriptions of Canadian graptolites, in *Report Geol. Surv. Canada, for the year* 1857, Toronto, pp. 109–145. The author refers the strata of Pointe-Lévis to the Hudson river group, adding that they form also the rocks of Quebec-city. Two of the species were published first in 1855 in *Canadian Naturalist*, vol. III, under the title: "Note upon the genus Graptolithns, and descriptions of some remarkable new forms from the shales of the Hudson river group, etc., etc." Mr. Hall repriuted the same paper in the *Twelfth Ann. Rep. State Cabinet Nat. Hist., State of New York*, pp. 47–58, Albany, 1859.

1860.—Billings (E.).—On some new species of fossils from the limestone near Pointe-Lévis, opposite Quebec. (*Canadian Naturalist*, vol. V, p. 301, August).

1860—Barrande (J.) and Marcou (J.)—On the primordial fauna and the Taconic system (*Proceed. Boston Soc. Nat. Hist.*, vol. VII, pp. 369–382, October). Barrande refers the fossiliferous limestone of Pointe-Lévis to the Taconic system; and Marcou calls the rocks of Montmorency fall quartzites instead of gneiss, and says that he did not see the fifty feet of Trenton limestone pointed out by Logan as existiug at the foot of the fall, nor the anticlinal axis with fault of Logan. It is the first hint of the grave errors committed in referring the strata of Pointe-Lévis, Quebec-city, and the foot of Montmorency falls, to the Hudson river group, the Oneida conglomerate and the Onondaga gypseous limestone. This paper has been called "turning point" of the Taconic questiou. Part of the paper has been reprinted, under the altered and false title of: "On the primordial fauna and the Taconic system of Emmons, in a

letter to Professor Bronn of Heidelberg," in the *Amer. Jr. Sc.*, vol XXXI, March 1861, pp. 212–215, in the *Canadian Naturalist*, vol. VI, pp. 108–173 and also in the "Geology of Vermont," vol. I, pp. 377–379. March 1862.

1861.—Logan (W. E.).—Remarks on the fauna of the Quebec group of rocks, and the primordial zone of Canada, addressed to Mr. Joachim Barrande, 15 January 1861. The author admits that the Hudson river group and Oneida conglomerate for the rocks of Pointe-Lévis and Quebec-city is an error, and he refers them now to the horizon of the Chazy and Calciferous. His explanation of the strata at Pointe-Lévis is so confused as to be incomprehensible. Reprinted in the *Canadian Naturalist*, vol. V, pp. 472–477, also in the *Amer. Jr. Soc.*, vol. XXXI. pp. 216–220; and in the "Geology of Vermont," vol. I, pp. 379–382.

1861—Hall (James).—On the primordial fauna and Pointe-Lévis fossils in a letter to the editors of the *American Journal of Science and Arts*, vol. XXXI, March 1861, pp. 220–226. The author opposes Barrande's conclusions in regard to "successive trilobitic fauna"; and maintains that on "paleontological evidence" and on "stratigraphical basis" the rocks of Pointe-Lévis belong to the Hudson river group. Reprinted in the *Canadian Naturalist* vol. VI, p. 113–120, and also in the "Geology of Vermont," vol. I, pp. 382–386.

1861.—Logan (W. E.).—Considerations relating to the Quebec group and the upper copper-bearing rocks of Lake Superior (*Canadian Naturalist* vol. VI, pp. 199–207, May 1861); with a vertical section extending from Montmorency to the Island of Orleans, p. 199; and a diagram at p. 206, showing the author's opinion on the deposit of the Potsdam, Quebec group, Birdseye, Black River, Trenton, Utica and Hudson river in the Montmorency region.

1861. — Barrande (Joachim). — Documents anciens et nouveaux sur la faune primordiale et le système Taconique en Amérique (*Bulletin Soc. géol. France*, vol. XVIII, pp. 203-321, Fevrier 1861, received in America August 1861. At pp. 209-216, chap. II. — "Faune nouvelle, découverte à la Pointe-Lévis près Québec, et renfermant des trilobites de forme primordiales;" and at pp. 315-221, "Observations au sujet de la communication de Sir W. E. Logan, sur la faune du groupe de Quebec." A very remarkable and impartial paper.

1861. — Billings (E.). — On some of the rocks and fossils occurring near Philipsburgh, Canada East (*Canadian Naturalist*, vol. VI, pp. 310-328.) Comparison of the upper limestone of Phillipsburgh with the Pointe-Lévis limestone, referred to the upper part of the Calciferous.

1861. — Marcou (Jules). — Sur les roches fossilifères les plus anciennes de l'Amérique du nord; deuxiéme lettre de M. J. Marcou à M. Elie de Beaumont (*Comptes rendus de l'Académie des sciences*, tome LIII, 4 November, 1861, pp. 915-921, Paris). First description of the Redoubt at Pointe-Lévis, with its primordial fauna as belonging to the Taconic system.

1861. — Marcou (Jules). — The Taconic and Lower Silurian rocks of Vermont and Canada (*Proceed. Boston Soc. Nat. Hist.*, vol. VIII, pp. 239-253, November). At p. 248, there is a "Theoretical section of the rocks of the vicinity of Quebec," with an explanation of the superpositions. It is a first attempt at a rational and exact classification of the strata of the environs of Quebec.

1862.—Billings (E.).—3. On some new species of fossils from the Quebec group. Synchronism of the Pointe-Lévis limestones (*new species of the Lower Silurian fossils*, pp. 57-96, issued June, 1862. Reprinted in *Paleozoic fossils*, vol. I, 1865, with alterations so great as to be regarded as another paper. The pages 57 to 67 are entirely different from the same pages 57 to 67 of the issue of June 1861. It is an incomprehensible confusion, showing the complete state of anarchy of the geological survey of Canada, after the publication of Barrande and Marcou's papers on the geology of the vicinity of Quebec.

1862.—Marcou (Jules).—Letter to M. Joachim Barrande on the Taconic rocks of Vermont and Canada, August 1862, Cambridge. The author gives an "abstract section for the vicinity of Pointe-Lévis, Chaudière and Quebec," with explanations, pp. 9-15. For the first time the existence of *lenticular masses of limestone, sandstone and puddingstone inclosed in the shales* are clearly shown and an exact classification and nomenclature of all the strata around Quebec is given, under the names of: "city of Quebec" group, "Pointe-Lévis and Redoubt" group and "Chaudière and Sillery" group for the Canadian Taconic. In this paper is the first notice of porphyry or diabase inclosed and crossing the strata of the Chaudière group. The paper marks a new departure for the stratigraphy of the environs of Quebec.

1863.—Logan (W. E.)—Letter addressed to Mr. Joachim Barrande on the rocks of the Quebec group at Pointe-Lévis; March 1863, Montreal. Reprinted in *Canadian Naturalist*. vol. VIII, pp. 183-194. A second attempt to explain the stratigraphy of Pointe-Lévis, crossing and blotting his explanation of 1861, and creating new stratigraphical confusions.

1863.—Billings (E.).—The parallelism of the Quebec group with the Ilandeilo of England and Australia, and with the Chazy and Calciferous. (*Canadian Naturalist*, vol. VIII, pp. 19-35.)

1863-—Devine (T.).—Description of a new trilobite from the Quebec group.—*Olenus? Logani*, Pointe-Lévis. (*Canadian Naturalist*, vol. VIII, April, pp. 95-98.)

1863.—Devine (T.).—Description of a new triobite from the Quebec group.—*Menocephalus Salteri*, Pointe-Lévis. (*Canadian Naturalist*, vol. VIII, June, pp. 210-211.)

1864.—Marcou (Jules).—Notice sur les gisements des lentilles trilobitifères taconiques de la Pointe-Lévis, au Canada (*Bulletin soc. géol. France*, vol. XXI, pp. 236-250, avril.). A minute description with section and map of a part of Pointe-Lévis.

1865.—Hall (James).—Graptolites of the Quebec group (*Figures and descriptions of Canadian organic remains*, Decade II). The shale, with graptolites of Pointe-Lévis are referred to the Calciferous and Chazy limestone. The introduction is reprinted in the "Twentieth Ann. Rep. State Cabinet of Nat. Hist. of the State of New York,' pp. 169-233, "with supplementary notes," pp. 234-240, Albany, 1868.

1865.—Billings (E.)—New species of fossils from the limestones of the Quebec group from Pointe-Lévis and other localities in Canada-East. (*Paleozoic Fossils*, vol. I, No. 5, pp. 185-206.)

1865.—Logan (W. E.).—Geology of Canada or Report of progress from its commencement to 1863, Montreal, 1863; accompanied by an "Atlas of maps and sections," Montreal 1865, and the "geological map of Canada and the adjacent regions, including the other British provinces, and parts of the United States," eight sheets, each 24x20½ inches; scale 25 miles to one inch, 1866. Although dated 1863, 1865 and 1866, the complete work was not issued and distributed until the spring of 1867. In taking 1865 for the year of publication of the work, it is a fair average of the dates inscribed on its three different parts. The bulky volume in 8vo, contains observations on the vicinity of Quebec in chapters ix, x, and xi, from pp. 196-296; in chap. xxii, pp. 861-864. On both the geological maps, the vicinity of Quebec is colored as Chazy and Calciferous formations, with a band of Hudson river groups, extending from the rear of the citadel to Montmorency. The author described a great fault or break, made by "an overturn anticlinal fold with a crack and a great dislocation running along the summit, passing just north of the fortress."

1866. — Richardson (James). — Geological Survey of Canada. Report of Progress from 1863 to 1866, Ottawa, 1866. Report of Mr. James Richardson, pp. 29-32.

1867. — Capellini (Giovanni). — Ricordi di un viaggio scientifico nell. America settentrionale nel MDCCCLXIII Bologna, 1867. The volume contains, Capitolo III, pp. 47-62, "Geologia della collina di Pointe-Lévis, Sezione geologica del Montmorenci," the "Natural Steps.' The rocks of Montmorency fall are called Quartzites, and the section of the fall, p. 55, is correct.

1870. — Richardson (James). — Geological Survey of Canada. Report of progress from 1866 to 1869, Montreal. Report of Mr. James Richardson on the south shore below Quebec, pp. 119-139. A geological map from the Chaudière to Trois Pistoles river, gives for the area between the Chaudière river and the village of Beaumont, the Sillery and Lauzon groups, placed above strata called Upper Potsdam; and the Pointe-Lévis group; according to the author the Pointe-Lévis group does not exist at Pointe-Lévis, and is not found until below Beaumont's village.

1879.—Selwyn (A. R. C.).—Geological Survey of Canada; Report of progress for 1877-78, Montreal, contains: "Report of observations on

the stratigraphy of the Quebec group and the older crystalline rocks of Canada," pp. 1*a*-8*a*. This paper with a few alterations in the title and in the first page, was read by Mr. Selwyn before the Natural History Society of Montreal, 24 Feb. 1879, and reprinted in the *Canadian Naturalist*, vol. IX, pp. 17-31, 1879.

1879. — Dawson (J. W.). — The Quebec group of Sir William Logan, being the annual address of the President of the Natural History Society of Montreal, for 1879.

1879. — Macfarlane (Thomas). — Remarks on Canadian stratigraphy (*Canadian Naturalist*, vol. IX, pp. 91-102).

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EXPLANATIONS OF THE SECTIONS TO ILLUSTRATE JULES MARCOU'S PAPER ON THE "GEOLOGY OF THE ENVIRONS OF QUEBEC." PLATES VIII AND IX.

Fig. No. 1. Section of Montmorency's fall. *a.* Black River limestone. *b.* Lower Trenton limestone. The strata between the quartzites at the foot of the fall and the river St. Lawrence are gray and black slates with beds of calcareous marl of the City of Quebec or Swanton group of the Upper Taconic, August, 1863.

Fig. No. 2. Section of Montmorency's fall, by Alfred R. C. Selwyn, June, 1884.

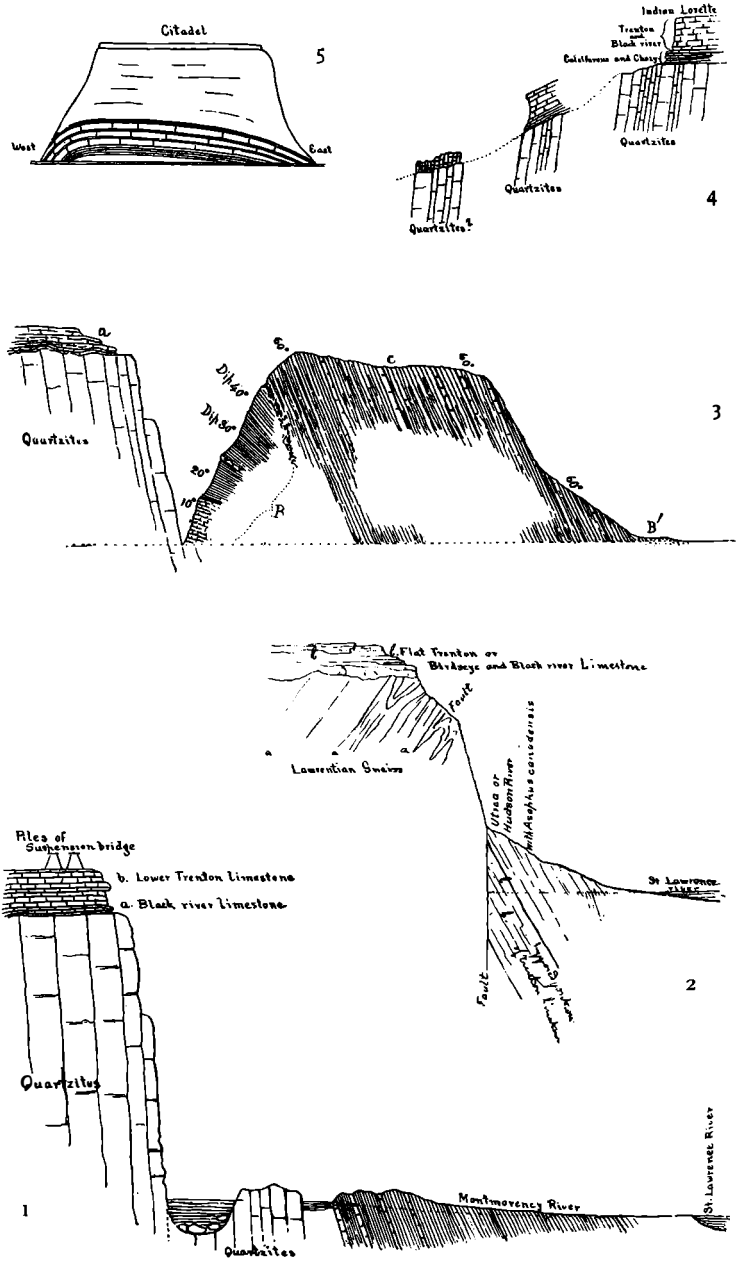
Fig. No. 3. Section from the Ravine on the east bank of Montmorency's fall to the River St. Lawrence. *a.* Black River limestone or Lower Trenton. Dip 5° southeast and almost horizontal at the summit of the fall. *B.* Upper Trenton and Lower Utica, composed of 20 feet of Upper Trenton limestone at the foot of the ravine; then 16 feet of gray slates; then 2 feet of limestone; then 35 feet of brown and gray slates. These 73 feet of strata have fallen into the ravine by a landslide. At the contact between the brown slates of the Utica and the black slates of the City of Quebec groups there is a great disorder and a confused stratification; some of the slates being verticales and even reversed dipping westward instead of eastward. *C.* Black and gray slates of the City of Quebec or Swanton slates. *B'*. A tongue of Upper Utica slates at the St. Lawrence river shore; another remain of a landslide.

Fig. No. 4. Interrupted section taken on the Charles River banks, from the village of Indian Lorette down the rapids, showing the inclination of the Calciferous, Black River and Trenton groups of strata by landslides.

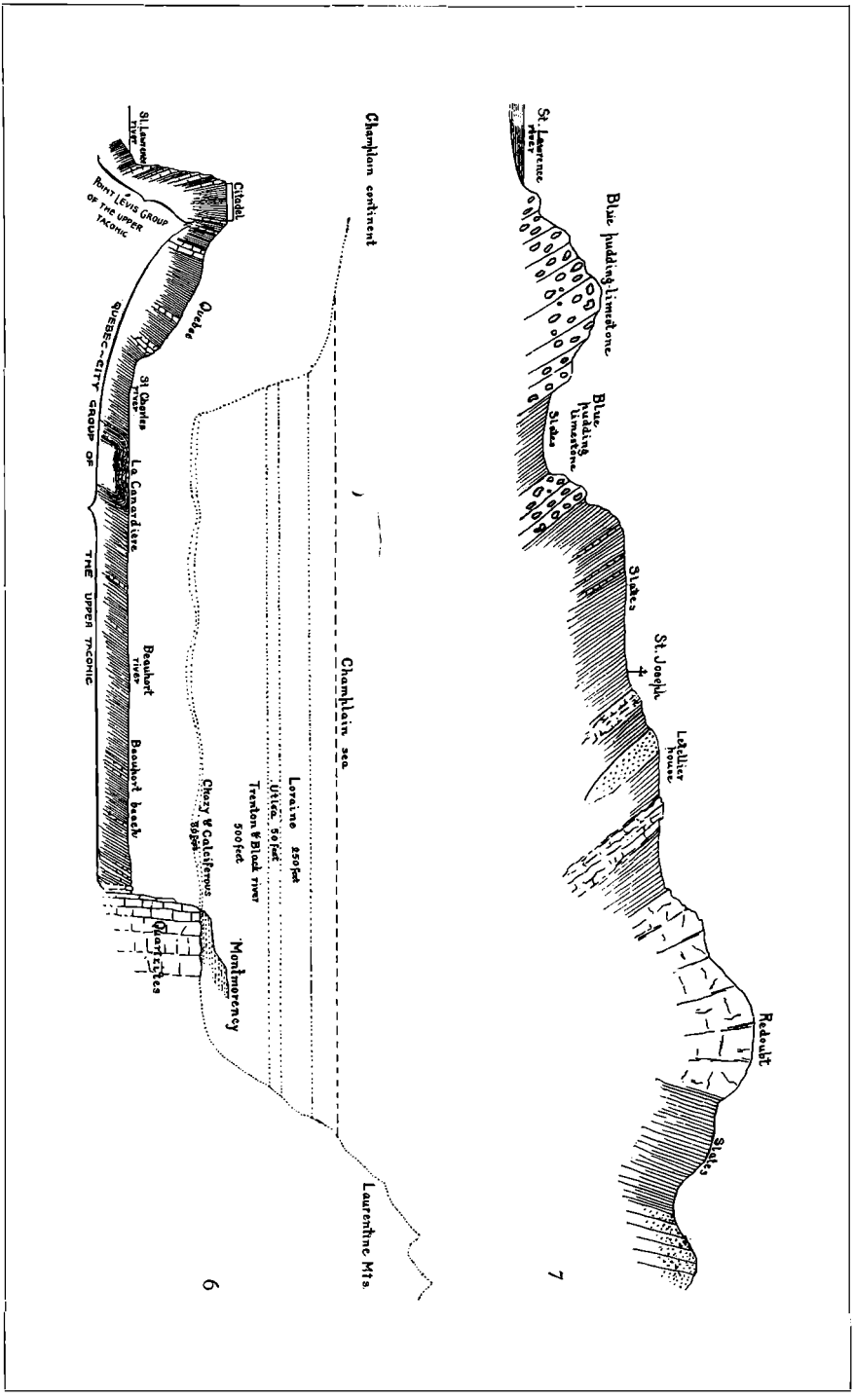
Fig. No. 5. Arched fold with a long rise of the strata at the base of the Citadel of Quebec, in following Champlain Street.

Fig. No. 6. Section from Montmorency to the mouths of Beauport and St. Charles Rivers across the city and Citadel of Quebec to the western foot of the Citadel.

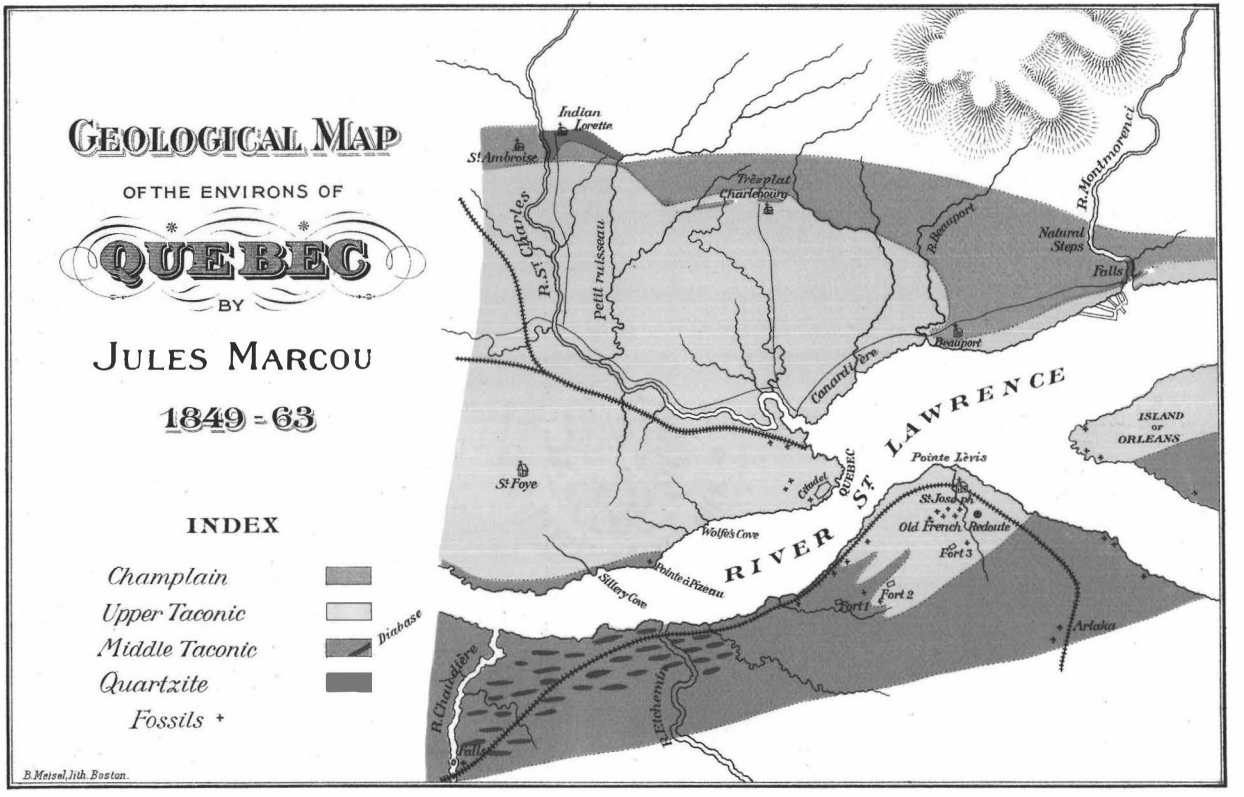
Fig. No. 7. Section from the St. Lawrence River, at the Point Lévis shoal to the St. Joseph's church and the Redoubt. The magnesian limestone of the Redoubt contains a Primordial fauna, and in following it after the fold of that lenticular mass; just near the Letellier house, a *Trinucleus* has been found with a *Dikelocephalus* in the same piece of limestone.



MARCOU, GEOLOGY OF QUEBEC.



MARCOU, GEOLOGY OF QUEBEC.


GEOLOGICAL MAP
OF THE ENVIRONS OF
QUEBEC
BY
JULES MARCOU
1849 - 63
INDEX
Champlain
Upper Taconic
Middle Taconic
Quartzite
Fossils +
Diabase
Indian Lorette
St Ambroise
R. St Charles
Petit ruisseau
Trespiat Charlebourg
R. Beauport
R. Montmorenci
Natural Steps
Falls
Beauport
Canard Fere
RIVER ST LAWRENCE
ISLAND of ORLEANS
Pointe Levis
St Foye
Citadel
Quebec
St Joseph
Old French Redoute
Fort 3
Wolfe's Cove
Fort 2
Fort 1
Sillery Cove
Pointe à Pizeau
Arlaka
R. Chaudière
R. Etchemin
Falls
B. Meisel, lith. Boston.