

ART. XXX.—*Considerations relating to the Quebec Group, and the Upper Copper-bearing Rocks of Lake Superior*; by Sir W. E. LOGAN, F.R.S., Director of the Geological Survey of Canada.†

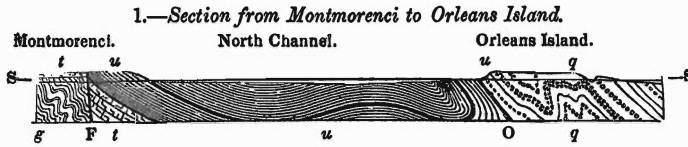
(Read before the Montreal Natural History Society, May, 1861.)

IN a communication addressed by me to Mr. Barrande on the fauna of the Quebec group of rocks, (this Jour., xxxi, 216,) after showing that the organic remains discovered last year at Point Lévis, placed the group about the horizon of the Calciferous formation, I stated that the apparent conformable superposition of the group on the Hudson River formation was probably due to an overturn anticlinal fold or overlap.

* In course of the preceding investigation a property of the *palmitate of silver* was noticed which I believe has not yet been placed on record. I allude to its becoming powerfully electric by friction. A small quantity of this salt, purified from extraneous fatty matters by digestion in ether, was gently rubbed in an agate mortar, when a sufficient amount of electricity was generated to cause the powder to fly out in every direction and cluster around the pestle and the hand holding it.—G. E. M.

† From the Canadian Naturalist and Geologist.

The character of this overlap is exhibited in the accompanying wood cut (fig. 1) of a vertical section of the neighborhood



Horizontal and vertical scale, 1 inch to a mile. *g*, Laurentian gneiss; *t*, Trenton limestone; *u*, Utica and Hudson River formations; *q*, Quebec group; *F*, Fault; *O*, Overlap; *S*, Level of the Sea.

of Quebec, extending from the Montmorenci side of the St. Lawrence across the north channel and the upper end of the Island of Orleans. The road from Beauport to Montmorenci runs over a floor of Trenton limestone, which has a very small dip towards the St. Lawrence; farther back from the river the rock has a gentle dip in an opposite direction, giving evidence of a very flat anticlinal form, which could scarcely be detected without the aid of the general distribution of the formations in the neighborhood. On the south side of the road there occurs a dislocation, which can be traced the whole way from Beauport church to Montmorenci falls, where the effect it produces is easily discernible. Here the channel of the Montmorenci is cut down through the black beds of the Trenton formation, to the Laurentian gneiss on which they rest, and the water at and below the bridge flows down and across the gneiss, and leaps at one bound to the foot of the precipice, which, immediately behind the water, is composed of this rock. At the summit, the Trenton beds are seen on each side; on the right bank they have a thickness of about fifty feet, and are marked by the occurrence of *Leptaena sericea* (Sowerby), *Strophomena alternata* (Conrad), *Orthis testudinaria* (Dalman), *Lingula crassa* (Hall), *Conularia Trentonensis* (Hall), *Calymene Blumenbachii* (Brongniart), and *Trinucleus concentricus* (Eaton). The dip of these beds is down the stream, at a very small angle; but at the foot of the precipice, and immediately in contact with the gneiss, about the same thickness of black limestone is tilted up to an angle of fifty-seven degrees. This is followed by about an equal amount of black bituminous shale with the same slope. In this attitude, these rocks climb up the face of the precipice, presenting their edges to the chasm on each side. They are succeeded by about eight feet of hard grey sandstone, weathering brown, in beds of from ten to eighteen inches, interstratified with black shale. On this repose grey arenaceo-argillaceous shales, composing the sides of the chasm out to the waters of the St. Lawrence; the distance being about a quarter of a mile, and the dip, which is towards

the St. Lawrence, diminishing gradually to about thirty-five degrees.

These tilted beds are fossiliferous, the species contained in the limestone being *Stenopora Petropolitana* (Pander), *Ptilodictya acuta* (Hall), *Strophomena alternata*, *Leptaena sericea*, *Orthis testudinaria*, *Camerella nucleus* (Hall), *Lingula* allied to *L. obtusa*, *Discina crassa* (Hall), *Bellerophon bilobatus* (Sowerby), *Conularia Trentonensis*, an undetermined *Orthoceras*, *Cyrtoceras constrictum* (Hall), *Calymene Blumenbachii*, *Cheirurus pleurexanthemus* (Green), *Trinucleus concentricus*, *Asaphus platycephalus* (Stokes). Those contained in the black shales are *Graptolithus bicornis* (Hall), and *G. pristis* (Hessinger). There is thus no doubt whatever that the limestones are of the Trenton and the shales of the Utica formation.

On the opposite side of the north channel, at the upper end of the Island of Orleans, there occur about 500 feet of black bituminous shales, interstratified with occasional beds of gray yellowish-weathering calcareous sandstone, and arenaceous limestone. They in some parts hold *Graptolithus bicornis* and *G. pristis*, and there is little doubt are subordinate to the Utica or Hudson River formation. They dip S.E. $< 50^\circ$, and there rests upon them (the contact being visible) a series of magnesian shales and conglomerates, dipping in the same direction and at the same angle. These magnesian strata are of the same character as those at Point Lévis, and belong to the Quebec group. They thus overlap the black shales, which are probably overturned as represented in the diagram (fig. 1).

In his explorations of last year on Lakes Superior and Huron, Mr. Murray ascertained that the lowest well characterized fossiliferous rock in that neighborhood belongs to the Birdseye and Black River group, and that it rests conformably upon the sandstones of Sault Ste. Marie. These sandstones and their equivalents, consisting of red and yellowish-white beds, are traceable on the south side of Lake Superior, from Marquette to the River St. Marie, and compose Sugar Island, and probably the north part of Neebish Island. They extend to the north part of St. Joseph Island, and are met with on the Island of Camp-

2.



a, Birdseye and Black River limestone; b, Ste. Marie sandstone; c, Huronian conglomerates; H, Level of Lake Huron; S, Level of the Sea. Horizontal and vertical scale, 1 inch to 1 mile.

ment d'Ours. In one of the white beds near Marquette, Mr. Murray obtained a *Pleurotomaria* resembling *P. Laurentina* of the Calciferous formation, and observed the occurrence, in the

same bed, of a species of *Scolithus*. The mass on Campment d'Ours is of the same color and friable character as the yellowish-white beds near Marquette, and is marked by the same *Scolithus*, and there is little doubt that the two exposures are of the same series. On Campment d'Ours the sandstone reposes on the Huronian series, and is eighty feet thick and very nearly horizontal, (fig. 2). It is succeeded in ascending order, by the following series of beds:—

Bluish-gray shales, interstratified with thin beds of yellowish compact limestone, presenting an escarpment over the sandstone. The fossils observed are <i>Stenopora fibrosa</i> , <i>Ptilodictya fenestrata</i> , <i>P. acuta</i> , <i>Strophomena alternata</i> , <i>Rhynchonella plicifera</i> , and a small undetermined <i>Lingula</i> , - - - - -	20
Measures concealed, - - - - -	60
Ash-gray compact limestone, in beds of from three to five inches thick, interstratified with a five-inch bed of drab colored compact limestone. Among the fossils are <i>Stenopora fibrosa</i> , <i>Glyptocrinus ramulosus</i> , <i>Strophomena alternata</i> , <i>Pleurotomaria subconica</i> , <i>Subulites elongatus</i> , <i>Ambonychia amygdalina</i> , <i>Cyrtodonta Huronensis</i> , <i>Vanuxemia inconstans</i> , <i>Orthoceras tenuifilum</i> , <i>O. Murrayi</i> , <i>Leperditia Canadensis</i> , and <i>Asaphus platycephalus</i> , - - - - -	4
Ash-gray compact limestones, in beds of from four to six inches, underlaid by a dark brownish-gray arenaceous limestone bed of about ten inches, and divided by thin layers of gray calcareo-argillaceous shale. All of these strata are very fossiliferous, and contain <i>Glyptocrinus ramulosus</i> , <i>Ptilodictya multipora</i> , <i>Coscium flabellatum</i> , <i>Strophomena alternata</i> , <i>S. filitexta</i> , <i>Rhynchonella recurvirostra</i> , <i>Orthis subequata</i> , <i>Vanuxemia inconstans</i> , <i>Cyrtodonta Huronensis</i> , <i>C. subcarinata</i> , <i>Pleurotomaria subconica</i> , <i>Trochonema umbilicata</i> , <i>Murchisonia perangulata</i> , <i>Orthoceras recticameratum</i> , <i>Cheirurus pleurexanthemus</i> , and <i>Leperditia Canadensis</i> , - - - - -	30
Ash-gray compact limestone, of the same character as the preceding, but still more fossiliferous. The beds contain <i>Tetradium fibratum</i> , <i>Stenopora fibrosa</i> , <i>Columnaria alveolata</i> , <i>Petraia profunda</i> , <i>Strophomena alternata</i> , <i>S. filitexta</i> , <i>Rhynchonella recurvirostra</i> , <i>Ambonychia amygdalina</i> , <i>Cyrtodonta Canadensis</i> , <i>C. Huronensis</i> , <i>C. mytiloidea</i> , <i>Vanuxemia inconstans</i> , <i>Ctenodonta nasuta</i> , <i>Pleurotomaria subconica</i> , <i>Eunema strigillata</i> , <i>Subulites elongatus</i> , <i>Orthoceras tenuifilum</i> , <i>O. Murrayi</i> , an undescribed <i>Cyrtoceras</i> , <i>Asaphus platycephalus</i> , and <i>Leperditia Canadensis</i> , - - - - -	16
	130

The fossils of these limestones leave little doubt that they belong to the Birdseye and Black River group; and the underlying sandstones and other rocks, constituting the upper copper-bearing series of Lake Superior, may thus represent the Chazy, Calceiferous, and Potsdam formations, and be equivalent to the Quebec group, with the black shales and limestones beneath it. This equivalency and the existence of an upthrow bringing the Quebec

group to the surface in the regions to the southeast, as already described in my letter to Mr. Barrande (this Journal, xxxi, 216) suggest the following considerations.

From the occurrence of wind-mark and ripple-mark on closely succeeding layers of the Potsdam sandstone, where it rests immediately upon the Laurentian series, we know that this arenaceous portion of the formation must have been deposited immediately contiguous to the coast of the ancient Silurian sea, where part of it was in some places exposed at the ebb of the tide. No want of conformity is known to exist between the Potsdam and Calciferous formations, and the Quebec group being of Calciferous age and 7000 feet thick, it follows that during the Potsdam period, while the sandstones of the formation were being deposited on a level with the surface of the sea, there must have existed a depth of at least 7000 feet of water over the area in which were subsequently deposited the strata of the Quebec group.

With the exception of a small mass of the Potsdam sandstone at St. Ambroise, we have no evidence of a marginal outcrop of this formation between the St. Maurice River and the Mingan Islands. No marginal outcrops of the Calciferous and Chazy formations have been observed from the longitude of Lake St. Peter to the same group of islands; and between the vicinity of Kingston and the north shore of Lake Huron, all three of these formations appear to be wanting. From the Mingan Islands to the Mohawk River in New York, the marginal outcrops of the Potsdam, Calciferous and Chazy united do not in any part much exceed 1000 feet in thickness; while the thickness of the Quebec group alone, is about 7000 feet. This, constituting the great metalliferous formation of the continent, is traceable, under various designations, from Gaspé to Alabama, thence sweeping round on the west side of the Mississippi, through Kansas, to Lake Superior, where it appears without any diminution in its volume.

From these facts, it would appear probable that, during the Potsdam period, the older rocks, which formed the coast of the Lower Silurian sea, extended, under comparatively shallow water, southeastwardly from the St. Lawrence and the Ottawa, to the fault which brings the Quebec group between Gaspé and the Mohawk; and southwestwardly from a line between the Mohawk and Lake Superior, as far as Alabama. All around this shallow area, they descended quickly into deep water; thus constituting a subaqueous promontory from the Laurentian and Huronian rocks of the north, and forming, with these, what Mr. James D. Dana has termed the nucleus of the North American continent.

But although the great volume of the Quebec and Potsdam groups, shows that over the area occupied by them, there must have existed a deep sea during the Potsdam period; it is to be

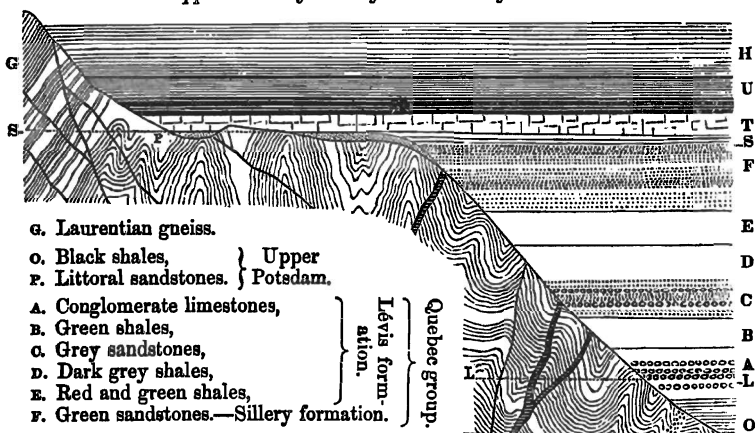
remarked, that many of the members, both of the lower and upper parts of the Quebec group, have by no means the characters of deep-sea deposits. It has already been stated, that the beds of passage between the littoral portions of the Potsdam and Calciferous formations, suggest the opinion, that, towards the termination of the Potsdam era, a gradual sinking of the surface had occurred. In order to obtain the conditions for the accumulation of the coarser sediments, which commence near the base of the Quebec group, it must be supposed, that, shortly after the beginning of the Calciferous period, a great continental elevation occurred; carrying the littoral deposits of the Potsdam, and the beds of passage just mentioned, high above the sea, and bringing the area at the base of the Quebec group comparatively near the surface. The successive coarse deposits of the group indicate a subsequent gradual subsidence, at unequal intervals, probably with subordinate oscillations, until the early shallow-water strata were again submerged; to be first partially covered over by deposits of the Chazy formation, and then, almost universally, by those of the Trenton and Hudson groups.

In this way may be explained the break which occurs in the succession of life between the Calciferous and Chazy, in the shallow-water deposits of these formations between the Allumettes Islands and Montreal, as well as among the Mingan Islands. The interruption in the succession of deposits between the base of the Trenton group and the Potsdam, at St. Ambroise; and that between the same base and the Laurentian, from the north shore of Lake Huron to Kingston, as well as in the vicinity of St. Paul and Murray Bays, and at Lake St. John on the Saguenay, is in the same way accounted for. The break in the succession of life between the Chazy and the Trenton group, is not so great as that between the Calciferous and the Chazy. It is not yet quite certain, that, at the marginal outcrop of the latter formations in Canada, a single species passes upwards into the Chazy; while about one-sixth of the species of the Chazy are known to occur in the Birdseye and Black River formation, at the base of the Trenton group. It seems to be in accordance with this, that we have evidence of a somewhat sudden submergence for the commencement of the Trenton period, and a somewhat rapid accumulation of its lower strata, the Birdseye and Black River limestones. Where these rest upon the Huronian and Laurentian series, the beds of contact are often composed of angular fragments of the underlying rock; and it frequently happens that the surface on which these beds rest, is rough, and broken into sharp projecting ledges and deep fissures, which were filled up and covered over by the deposits in question, before sufficient time had elapsed to permit the surface to be worn down. Instances in illustration of this occur on the Snake Islands, west of Lacloche, in Lake Huron, where the Birdseye

and Black River formation rests on the quartzites of the Huronian series; and at Marmora, where it is supported by Laurentian rocks. Dr. Dawson has pointed out a striking instance of these phenomena at Hog Lake in Huntingdon; other examples occur at Sloat's Lake in Loughborough and its vicinity, as well as at Kingston Mills. The same conditions may be observed in the neighborhood of Murray Bay.

As an instance of the probably rapid slope of the bottom of the Lower Silurian sea from shallow to deep water, during the Potsdam period, in the neighborhood of Quebec, we see that the surface of the quartzose gneiss now supporting the Trenton formation at the Falls of Montmorenci, must have been 7000 feet above the gneiss under the island of Orleans; while the distance between the two positions does not much exceed a mile and a half. This would give a slope of nearly forty-five degrees; and perhaps it would not be extravagant to take this as representing the inclination along the whole line to Alabama. As the Potsdam and Quebec groups accumulated, the edges of their strata would abut against this slope; and ultimately both these, and the early shallow-water deposits on the higher terrace, would be

3. *Supposed arrangement of the strata before the break.*



t. Trenton group of limestones; u. Utica shales; h. Hudson River sandstones and shales; l. l. Sea level at the commencement of the Quebec period; s. s. Sea level at the close of the Potsdam, and also at the beginning of the Trenton period. Vertical scale of the section, one inch to a mile.

covered over by the Birdseye and Black River, the Trenton, the Utica, and Hudson River formations. This we have endeavored to represent in the accompanying ideal diagram; in which it will be perceived that the lowest of these formations is shown as resting (at p.) on one of those littoral deposits of Potsdam sandstone, like that at St. Ambroise, which are still met with along the marginal outcrop.

The strike of this rapid slope in the bottom of the ancient sea, coinciding with the break, had, as already indicated, a general northeastward bearing, from Lake Champlain to the vicinity of Cape Chatte. The present trend of the Laurentian gneiss, from the neighborhood of Quebec to Pointe des Monts, has a rude parallelism with it; but farther down the valley of the St. Lawrence, while the line of break turns gradually eastward, and ultimately south of east, in Gaspé, the trend of the gneiss becomes northward for about sixty miles, then eastward for three hundred miles, and finally northeastward for two hundred miles more, to the Atlantic extremity of the Straits of Belle Isle. This divergence of the two lines would lead us to anticipate an area of shallow water during the Lower Silurian period; so protected from disturbance that any strata occurring there, might be expected to present a comparatively horizontal attitude, like that of the Lower Silurian formations on the same side of the break to the west. We accordingly find, in the Mingan Islands, in Anticosti, and on the Straits of Belle Isle, the Lower Silurian deposits in such an attitude. In the latter locality, however, the volume of the undisturbed strata would appear to indicate that the bottom shelved more gradually before reaching the slope. The increase of the dip in approaching Bonne Bay in Newfoundland, suggests that we may expect to find the break somewhere in that neighborhood.

Without enquiring into the origin of the forces which may have produced the corrugations of the earth's crust, we may suppose that if a sufficient lateral pressure were applied to the strata thus accumulated and arranged, there would result a series of parallel folds running in a direction at right angles to that of the force, with prevailing overturn dips towards the line of resistance. The solid crystalline gneiss in the case before us, offering more resistance than the newer strata, there resulted a break coinciding with the inclined plane at the junction of these with the gneiss. The lower palæozoic strata, pushed up this slope, would then raise and fracture the formations above, and be ultimately made to overlap the portion of these resting on the edge of the higher terrace; after probably thrusting over to an inverted dip, the broken edge of the upper formations. The shallow-water strata of the higher terrace, relieved from pressure by the break, would remain comparatively undisturbed; and thus the limit of the more corrugated area would coincide with the slope between the deep and shallow waters of the Potsdam period. The resistance offered by the buttress of gneiss would not only limit the main disturbance; but it would probably also guide or modify, in some degree, the whole series of parallel corrugations, and thus act as one of the causes giving a direction to the great Appalachian chain of mountains.