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STRATIGRAPHY OF THE TRENTON GROUP

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STRATIGRAPHY OF THE TRENTON GROUP

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When Lardner Vanuxem in 1838¹ first used the term Trenton limestone to designate a stratigraphic succession well shown at Trenton Falls, N.Y., he was faced with no appreciable problems. Here was a prominent and easily identified assemblage of sedimentary strata, separated from black shales above (later to be called the Utica Slate by E. Emmons² in 1842) and below from an assemblage of various beds which Vanuxem himself in 1842³ named the Black River Limestone. The shale beds above contained a few characteristic fossils, mostly graptolites, among which he mentioned Graptolites dentatus, Graptolites scalaris, Triarthrus beckii, Trocholithus uticus. The Black River below could be recognized by the presence of Fucoides demissus and Cyathophyllum s [Sp.]. Within the Trenton limestone he collected Favosites lycopodites, Orthis testudinaria, Strophomena deltoidea, Lingula ovata, Calymene senaria, Isotelus gigas, and Cryptolithus tessellatus. Moreover, these stratigraphic subdivisions, and their fossils, could be traced east and west of Trenton Falls. The picture was simple indeed. But - could Vanuxem or Emmons, or any of their contemporaries, have lived on until today they would have witnessed the complete abandonment of the three stratigraphic terms as originally applied, and the hoary nomenclature of the

characteristic fossils has, except for the trilobites, given way to modern designations. In the cases of both rocks and fossils new discoveries and refinements of analysis have multiplied stratigraphic and paleontologic problems so that today we settle one only to set up two or three more.

Thus, Vanuxem could not have foreseen that what he called Utica would, still within New York or adjacent Ontario, be known in part by such formational names as Atwater Creek, Billings, Collingwood, Deer River, Dolgeville, Eastview, Gloucester, Holland Patent, Loyal Creek and Nowandaga. Or that the Black River limestone would by division and regrouping come to be known under the names Chaumont, Coboconk, Gull River, Leray, Lowville, Moore Hill, Mount Merino, Normanskill, Pamela, Shadow Lake, and Watertown. As for the Trenton limestone, he would have seen the following terms introduced; Amsterdam, Canajoharie, Cobourg, Denmark, Hallowell, Hillier, Hull, Kirkfield, Napanee, Picton, Rockland, Schenectady, Selby, Sherman Fall, Shoreham, and Snake Hill.

Thus progress is attended by a proliferation of the nomenclature, sometimes wise and advisable, sometimes troublesome, occasionally unprofitable.

One is reminded here of the intellectual illumination that overtook Amos Eaton, one of the early founders of North American geology. In 1824 he wrote⁴: "The recent

custom among geologists of cutting up and subdividing, seems to be upon the point of ruining the simplicity of the Wernerian arrangement." However, a few years later⁵, in one of our earliest geological textbooks, he observed that, because of "these splendid discoveries, which overwhelm the strongest imagination with wonder and amazement, some reformation seems to be required; even among those rocks where Lehmann and Werner began their labors". For the above quotations I am indebted to the clear and extended account of the history of the Trenton Group by Kay⁶.

The simplicity inherent in the way the New York geologists treated the stratigraphic problems of their day was also in fashion when Logan first began to work in the Quebec lowland. Prior to his time little had been done other than to refer all of the local Ordovician rocks to the Secondary Series. Even in his Report of Progress for 1847-48⁷ he grouped all local limestones around Montreal together as the Montreal Limestone. Later, in his monumental opus magnum⁸, usually called Geology of Canada, 1863, he adopted the terminology already developed by the New York State geologists, and referred to the local rocks as, among others, Black River, Trenton, and Utica. He saw no problem involving the Trenton--Utica boundary, the former was limestone, the latter shale. Writing of the Birdseye (now Lowville), and Black River (now Leray), and the Trenton,

he remarked "we are not prepared for the present, in representing the distribution of the whole series on the map, to distinguish its parts by different colors" (1863, p.137). He devoted twenty pages (136-156) to a careful description of the distribution and characteristics of Black River and Trenton strata between Montreal and Quebec, without however, venturing any separation into formations. He did give, in some detail, a stratigraphic section at Montreal in which his five subdivisions can be recognized and related to the modern formations.

Throughout the balance of the nineteenth century, neither in New York nor in Quebec, had much further progress been made, with one or two minor exceptions, in separating the Trenton rocks into workable formations. Ellis⁹, in 1896, missed a fine chance to bring some of the recent developments in New York to bear upon our region, but was content with the observation that "the whole subject of the Trenton has, however, been so thoroughly discussed in the Geology of Canada, that little further remains to be said on the subject". It was not until 1912 and 1914 that Johnston¹⁰ proposed the first stratigraphic classification, and this from Ontario, of Trenton rocks. His subdivisions were named from their prominent faunal content, and were as follows:

Hormotoma and Rafinesquina deltoidea beds

Prasopora beds

Crinoid beds

Dalmanella beds

These subdivisions proved to be very useful in Ontario, and could

be carried into New York. Coincident with Johnston's 1914 paper the names were translated, somewhat freely, into geographic designations by Raymond¹¹. These latter, with subsequent modifications, are shown in the table below, and are still current in New York and Ontario.

<u>Johnston, 1914.</u>	<u>Raymond, 1914</u>	<u>Faunal zones.</u>
<u>Hormotoma and Rafinesquina deltoidea beds</u>	Upper and Lower Picton. Later changed to Coburg	<u>Fusispira and Hormotoma zone</u> <u>Rafinesquina deltoidea zone</u>
<u>Prasopora beds</u>	Trenton. Later changed by Kay to Sherman Fall	<u>Prasopora zone</u>
Crinoid beds	Hull	
<u>Dalmanella beds</u>	Rockland	<u>Triplecia extans zone</u>

When, in 1938, the writer began a study of the St. Lawrence lowland for the Quebec Department of Mines, to which he is indebted for permission to use hitherto unpublished data, Raymond's classification had just been somewhat elaborated in detail by Kay, whose work, already referred to above, brought together and analysed previous suggestions concerning Trenton subdivisions, and has proved to be invaluable to all workers in that group. One fact became immediately apparent, that none of the Ontario or New York Trenton formations could be recognized as such in Quebec. The so-called Black River formations - Pamela, Lowville, and Leray - are in large part lithologically similar over the

whole wide area mentioned, and much the same might be said of certain parts of the Utica, but the Trenton of the Quebec lowland was a thing apart.

Throughout this area there has nowhere been any difficulty in deciding upon the boundary between the Trenton and the underlying Black River. Both, however, are replete with domestic troubles. Between the Trenton and the Utica there is as a rule little trouble in fixing the boundary on the northwest side of the St. Lawrence; to the southeast doubt and uncertainty reign.

On the map shown in Figure 1 there are plotted those parts of all known well logs embracing Trenton formations. They are concentrated along both sides of the St. Lawrence River. If then we draw an arbitrary line A - A and project the nearby logs upon it from both sides, although we introduce certain difficulties, the relationship of the formations about to be referred to is clearer. In addition, in wider columns there are given the average thicknesses of the Trenton formations as seen and measured in outcrop for each map-area where such data are available.

Throughout the area lying northwest of the St. Lawrence River, one formation, and only one, is recognizably persistent. This is the Deschambault limestone of Lower Trenton (Hull) age. Everywhere it is a light gray, fragmental,

crystalline limestone, remarkably pure, and contains a large and distinctive fauna of Hull age. It is therefore a logical horizon from which to develop the section upward and downward. In ~~Figure~~ ^{Figure} 1 the line A' - A' is the datum for the top of the Deschambault.

The Deschambault limestone is not the lowest unit of the Trenton. In practically all appropriate outcrops, and in some cases in well logs, a thin formation intervenes between the Deschambault and the Black River. On the Ouareau River, there is a development of 19 feet of dark dense limestone characterized by an abundance of sections of gastropods, which, of course, are virtually impossible to extract whole. This lies unconformably upon the Leray, and is covered unconformably by the Deschambault. It contains a large fauna of Trenton affinities, and because of its intermediate position deserves to be called of Hull age.

Without doubt this is represented at Montreal by the 10-12 foot bed of unfossiliferous limestone¹² especially when it is recognized that the same rock type occurs at St. Vincent de Paul, and there carries abundant gastropods. The formation can be followed from Montreal northeastward through Joliette to the Yamachiche River, but not beyond.

Immediately northeast of the St. Maurice River, at Radnor Forges, there is a good series of exposures along

Rivière au Lard. At the Fontaine quarry near the southern limit of the exposures there is a good section of the basal Trenton and upper Black River. Here two feet of Deschambault limestone are underlain by 8 feet of dark, thin-bedded, crystalline limestone with an abundance of shaly partings. Bryozoa and inarticulate brachiopods make up the bulk of the fauna. The list of 26 species includes both Black River and Trenton forms, with, however, a few distinctive Trenton species, such as Receptaculites and Dinorthis browni. Because the faunal break is far less marked here than between the Ouareau and Deschambault formations it is not unreasonable to assume that the Ouareau is, if anything, younger than the Fontaine formation.

The next indication of a development between the Black River and the Deschambault is not seen until one comes to the Ste. Anne River. There, downstream from the bridge at St. Alban, about 5 feet of hard dark splintery crystalline to dense limestone, in part massive, in part thin bedded, lie below the Deschambault. An abundance of shaly partings occurs throughout. Fossils are rare, and none was obtained whole, but the abundance of Dalmanella indicates a Trenton age. The topmost Black River bed here contains heads of Columnaria, across the truncated surfaces of which lie the basal St. Alban beds.

Further north, along the Jacques Cartier River, there is a much greater development of beds of Rockland age. At Pont Rouge, Portneuf County, exposures are good along the river above and below the highway bridge. Upstream, a continuous section can be followed for one thousand feet along the right bank, where 32 feet of Trenton beds below the Deschambault are splendidly displayed, and are underlain by Black River limestones and sandstones. The Trenton beds are unlike any of the others seen, and consist of crystalline and dense, almost lithographic limestones, both thin- and thick-bedded. Fossils are common in some beds. Sinclair and Flower ¹³ have published faunal lists indicating a Rockland age for these beds.

Thus the Ouareau, Fontaine, St. Alban, and Pont Rouge formations all occupy much the same short time interval, but differ in lithology. All carry Trenton faunas, with slight Black River affinities. It is reasonable to suppose that following the widespread submergence of Black River time minor and local warpings took place, interfering with what had been progressive and uniform submergence so that different lithic types could be accumulated. Hardly had these evidences of early Trenton crustal unrest manifested themselves in the formation described above when Deschambault sedimentation masked them all equally with a cover of organic debris which

blanketed the whole area.

If the Rockland beds show great diversity of environmental conditions of origin, the Deschambault limestone is remarkably uniform. In the northern part of the area being discussed it begins with beds of remarkably pure crystalline limestone, interbedded with mats of bryozoa set in a shaly limestone matrix. Though the bryozoan phase may persist throughout the formation, it disappears in general stratigraphically upward and geographically towards the southwest, so that the upper half or more of the Deschambault consists in places almost wholly of a nearly pure, light gray, cross-bedded, crystalline limestone composed of current transported fragments of fossils, mostly echinoderms, with here and there thin beds of coquinoïd limestone. Throughout it is pale brownish, and smells of petroleum. In fact, at St. Marc des Carrières and in one or two cores, droplets of petroleum have been liberated from small quarter inch cavities. Nowhere is there any indication of the source area of the fossil fragments. Whole crinoids or cystids are unknown, and it can only be surmised that further inland, in shallow, warm, well lighted waters sea-gardens of crinoids and cystids covered the Trenton sea floor, and that their dissociated plates and columnals were progressively washed seaward to accumulate as a coquinal "sandstone" in quieter and somewhat deeper waters.

The general absence of whole fossils, except in a few thin zones, supports this view.

The differential sinking along this shelf area was resumed for the remainder of Hull time. In the northeast there lies upon the Deschambault a formation known as the St. Casimir, made up of a great variety of lithologic types of limestone, with a large fauna including Receptaculites, more closely allied to that of the preceding Deschambault than to that of the succeeding Neuville of Sherman Fall age. In the Portneuf and the Grondines areas the thickness of this formation is 180 to 190 feet. Except for a questionable identification of 50 feet at St. Louis de France it is not known southeast of the Ste. Anne River.

All higher beds are of Middle and Upper Trenton ages. In the Montreal area the succeeding formation is the Montreal limestone, perhaps 375 feet thick, abundantly fossiliferous with a fauna closely resembling that of the Sherman Fall formation. Its thickness, like its lithology, is very erratic. Northeast from Montreal it ranges between 100 and 300 feet as far as Louiseville. Thence northeastward its variation lies between 50 and 310 feet. It cannot be recognized with assurance beyond Batiscan where 40 feet of cuttings have been assigned to it. It is characterized by a great irregularity of sedimentation, nearly every type of limestone combined in nearly every proportion with shale, with variability

in regularity and irregularity of bedding, and even in its reaction to weathering.

Northeast of the St. Maurice River the Middle and Upper Trenton can rarely be separated on lithological grounds alone, and where fossils of Sherman Fall or Cobourg ages can be located, they occur in limestones that are practically identical. Nowhere is there anything resembling the irregularity of the Montreal limestone lithology. Instead bedding is regular and shaly partings divide the limestone into roughly similarly thick beds. The entire thickness from the St. Casimir to the Utica is admirably exposed along the Neuville shore from which locality this development takes its name, and where it reaches a thickness of 470 feet. Should later developments make a subdivision into Middle and Upper Trenton parts desirable, it would be my judgement that the name Neuville should be restricted to the Middle Trenton and the name Grondines be used for the Upper Trenton division.

Southeast of the St. Maurice River the Upper Trenton beds covering the Montreal formation are included in the Tetreauville formation, which is not altogether different from the Neuville, except in general for a proportionally greater thickness of the shaly interbeds. Otherwise the rhythmic depositional features are about the same. However, there is one other major difference. Included within the

Tetreauville between Montreal and Joliette there are lenses of limestone known earlier as the Terrebonne formation. This is characterized by a lack of definite bedding, and hence of shale interbeds. Chemically and faunally there is no difference between this rock and the Tetreauville. The Terrebonne is sometimes found at the top, or entirely within the Tetreauville, and it is obvious that it must be considered as a series of lenses of limestone consisting of the same material as that of the Tetreauville, but whose orderly deposition in regularly alternating beds of limestone and shale was disallowed presumably by constant agitation of the waters in restricted localities during the Terrebonne deposition. It may be called a roving member within the Tetreauville.

In thickness the Tetreauville ranges from 300 to 500 feet thick near Montreal, dropping fairly abruptly to 100 to 200 feet north of Lake St. Peter, and is unrecognized northeast of the St. Maurice River.

The Tetreauville was obviously deposited in very quiet water, as was the Neuville to the northeast, or the even bedding of the shaly interbeds would not be so marked. The difference between the sedimentation in the two areas lies probably in the generous supply of mud to the southwestern part, and its virtual exclusion from the northeastern part.

Upon the Tetreauville (or Terrebonne), and the

ROCK STRATIGRAPHIC UNITS

T R E N T O N G R O U P	<u>ONTARIO</u>	<u>MONTREAL</u>	<u>GRONDINES - NEUVILLE</u>
	COBOURG	TETREAUVILLE INCL. TERREBONNE	NEUVILLE
	SHERMAN FALL	MONTREAL	
	HULL	DESCHAMBAULT	ST. CASIMIR
			DESCHAMBAULT
ROCKLAND	OUAREAU	FONTAINE - ST. ALBAN--PONT ROUGE	

*Table
Insert on p. 14*

Neuville, the Utica was deposited without any sign of gradation (save in one core). In one locality, along the Jacques Cartier River the limestone and shale interfinger for a few feet, but the types are distinct and no gradations are known.

Table 1

In many of the cases of differential sedimentation mentioned above, a separation occurs fairly close to the St. Maurice River (Table 1). This is also true for other sedimentary rock groups. Neither the Potsdam nor the Beekmantown dolomite quite reaches that river. The Chazy limestones and sandstones are deflected southward at about that spot, and though they continue towards the northeast it is only in the central part of the lowland. Black River beds here first include a basal sandstone. The Deschambault carries bryozoan mats only northeast of here. A drill hole at Cap de la Madelaine shows Trenton limestone resting on Precambrian. This points to a low Precambrian ridge occurring more or less along the St. Maurice River, serving to control sedimentation on each side, and to allow different rock types to develop to the north and the south. The similarity of the Deschambault, at least in its upper part on both sides of this barrier, may mean that the groves of echinoderms which covered the sea floor on both sides of the barrier were continuous further landward, or that the division of the

sea floor into two areas did not hinder the development of such sea-gardens.

If, now, we draw a curved line more or less following the curve of the St. Lawrence and south thereof (line B - B, Figure 1), two features stand out prominently. First, the thicknesses of the Trenton beds southeast of this line are much greater than to the northwest, and second, the limestone so characteristic of the region northwest of the St. Lawrence is largely replaced by shale. These two differences cannot but be logically connected in thought.

First, the thickening towards the southeast. This is well known within a few miles of Montreal, where the entire Trenton section is less than 800 feet. Immediately south of the river incomplete sections swell up to 950. Still further southeast and well beyond line B - B, a few miles southeast of St. Johns, the Montreal formation alone reaches a thickness of 1000 feet, and in one well log the Trenton shales attain their maximum known thickness of 2480 feet, all of which lies above some 20 feet of recognizable Montreal limestone.

Towards the northeast fewer differences exist. Opposite Three Rivers total Trenton thicknesses of over 1000 feet have been measured in two wells (two to three times the total thicknesses measured across the St. Lawrence), and in both cases half the section is made up of shale. There

are many other well logs available from this region but none of them shows recognizable Trenton rocks. However, the sections of Utica and Lorraine beds are correspondingly thicker than their counterparts alongside the St. Lawrence. This arc therefore may be considered a hinge to the southeast of which subsidence was more rapid than on the relatively stable shelf to the northwest. Sedimentation consisted more of argillaceous material trapped in the deeper water, than of clear water limestone. Here then is the edge of the Appalachian geosyncline, or more probably of the miogeosynclinal part thereof. Excess of muddy sediment apparently did not occur until the Middle Trenton had begun, but from that time on practically all the sedimentation south of the arc was predominantly argillaceous. The excessive subsidence, however, may have begun early in the Ordovician, although the evidence from well logs is not clear on that point.

In outcrop, Trenton limestone occurs in only two localities southeast of the hinge. At St. Johns there are exposures, unmeasured, of Middle Trenton, and at St. Dominique the lower part of the Middle Trenton and possibly a few tens of feet of Hill beds can be seen. Above that, however, is a great and unmeasured thickness of folded Trenton and higher shales, cut off and covered to the southeast by the 'Sillery' sandstones of the Granby Slice.

Following the Trenton Stage thick blankets of shale

and fine-grained sandstone up to 4000 feet thick spread over the whole area. These thicknesses have been mostly taken from well logs southeast of the arc. On the basis of our knowledge of the thickness of the Trenton on both sides of the hinge, the 2500 feet of Lorraine and Richmond marine shales of the measured Nicolet River section might have been the equivalent of no more than, say, one thousand feet along the St. Lawrence; and conversely, still further to the southeast, correlative beds may well have reached 5000 feet or more in thickness. The Queenston red shales and sandstones are known to have thicknesses of at least 2000 feet from well logs southeast of the hinge. The corresponding thickness of such beds along and north of the St. Lawrence River may not have reached a thousand feet. This probable variation in thickness, and the consequent dips of the beds involved, should have considerable influence upon our thinking about the cover beneath which our present sediments may have been buried, about their oil and gas potential, and in particular should be taken into account when we postulate the thickness of strata pierced by, and perhaps once covering, the Monteregian Hills.

It is a fitting comment upon the interrelationships of all branches of Geology that a discussion of sedimentary rocks by a softrock geologist should end with a reference to igneous intrusions.

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