

AMERICAN JOURNAL OF SCIENCE

JULY 1933

THE ORDOVICIAN TRENTON GROUP IN NORTH-WESTERN NEW YORK: STRATIGRAPHY OF THE LOWER AND UPPER LIMESTONE FORMATIONS.

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INTRODUCTION.

The Mohawkian series of the Ordovician system is divided into the Black River and Trenton groups. The type region of the Black River group is along the Black River near Watertown, New York; the Trenton group is typically but incompletely developed at Trenton Falls, Oneida County, New York. In Ontario the Trenton group has been classified into the formations illustrated in the columnar section, Fig. 1.¹

Certain features of the Trenton limestones were reported by Emmons in his Survey of the Second District.² Parts of the region have been discussed in later state reports³; and Clark has detailed the section along Roaring Brook at Martinsburg.⁴ Raymond has discussed the correlation of the northwestern New York sections with those in Ontario.⁵ The stratigraphy of the overlying black shales of the Utica formations has been described by Ruedemann.⁶

¹ Raymond, P. E., Trenton Group in Ontario and Quebec, Geol. Survey, Canada, Summary Rept. for 1912, 346, 1913; Fauna of the Trenton Group, Geol. Survey, Canada, Museum Bull. 31, 1, 1921; Kay, G. Marshall, Stratigraphy of the Decorah Formation, Jour. Geol., 37, 664, 1929.

² Emmons, Ebenezer, Geology of New York, Part II, 1842.

³ Cushing, H. P., Geology of the Thousand Islands Region, New York State Museum, Bull. 145, 1910; Miller, W. J., Geology of the Port Leyden Quadrangle, Bull. 135, 1910.

⁴ Clark, T. H., A Section in the Trenton Limestone at Martinsburg, New York, Bull. Mus. Comp. Zoology, Harvard, 63, 3, 1919.

⁵ Raymond, P. E., Expedition to the Baltic Provinces of Russia and Scandinavia, Bull. Mus. Comp. Zoology, Harvard, 56, 252, 1916.

⁶ Ruedemann, Rudolf, Utica and Lorraine Formations of New York, Part I, Stratigraphy, New York State Museum, Bull. 258, 44, 1925.

It is the purpose in this paper to discuss the relations of the basal Trenton limestones to underlying beds, and of the uppermost Trenton limestones to the overlying beds in northwestern New York.

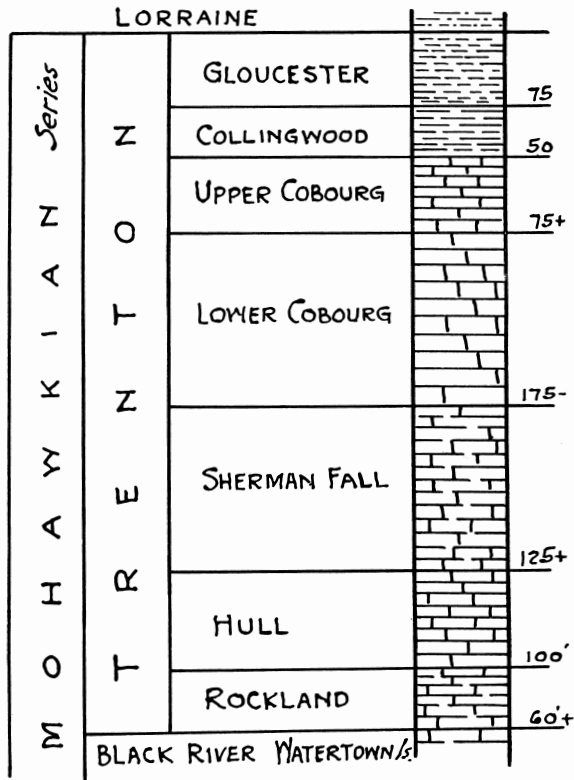


Fig. 1. Columnar section of the Trenton group. The thicknesses of the limestone formations are the maxima in northwestern New York; the shales are represented as at their type localities in Ontario.

RELATIONS OF THE BASAL TRENTON TO THE BLACK RIVER GROUP.

There are exposures of the contact of the Black River and Trenton groups to the southwest of the Black River from north of Boonville to near Dexter, and north of Lake Ontario as far west as Three Mile Bay (see Fig. 2).

The uppermost member of the Black River group, the Watertown limestone, occurs beneath the Trenton in all the

exposures examined. The rock is consistently an almost black, rather fine-textured, massive, thick-bedded limestone weathering to light-gray, heavy ledges that are solution-channeled and rounded; black nodular chert is not infrequent. Characteristic fossils, such as *Gonioceras anceps* Hall, *Actinoceras tenuifilum* (Hall), *Plectoceras undatum* (Conrad), *Endoceras subcentrale* Hall, *Columnaria halli* Nicholson and *Stromatocerium rugosum* Hall, have been found in many exposures. All have

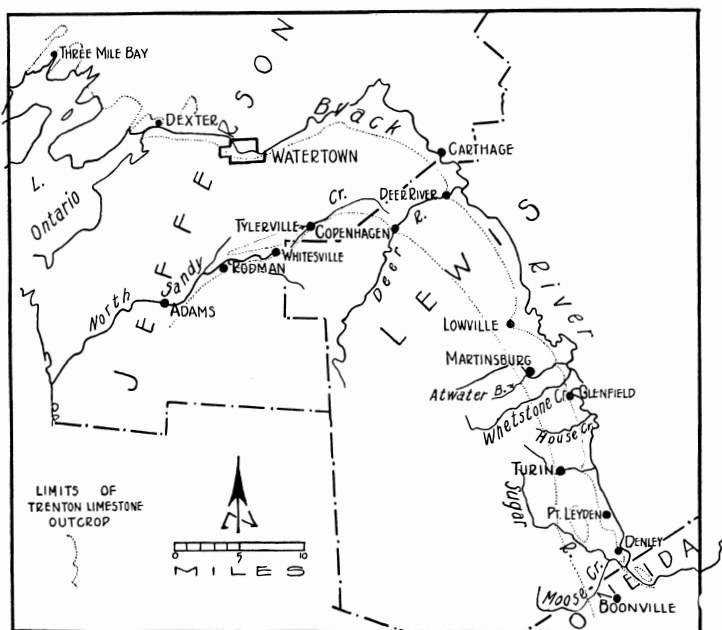


Fig. 2. Map of that part of northwestern New York in which the limestones of the Trenton group outcrop.

been seen in the quarries at Pamela station (New York Central Railroad), 2 miles east of Watertown, where the Watertown limestone is 23 feet thick; along Deer River at Deer River village; in the exposures in the field south of Roaring Brook above East Martinsburg; and in the quarries south of Denley station, where the Watertown is 9 feet thick. The underlying limestones of the Leray are plane-bedded and much thinner bedded; *Tetradium fibratum* Safford is frequently but not invariably abundant.

The Rockland formation, oldest of the formations of the Trenton group, has its type locality at Rockland, Ontario, 30

miles east of Ottawa. In New York, its top has been considered to be the uppermost bed in which *Triplecia cuspidata* (Hall) occurs in abundance. The formation was at one time called "The Triplecia Beds," and *T. cuspidata* occurs with other species of the genus at the type locality.⁷ The type specimen of the species was found at Lowville, New York.

Triplecia cuspidata is abundant in a limestone bed 44 feet above the base of the exposed Trenton along the stream a half mile west of Three Mile Bay village, Jefferson County. It is abundant in beds to 54 feet above the top of the Black River group by the roadside along the Dexter-Brownsville road 2 miles east of Dexter; the nearby quarry is the type locality of the Hounsfield metabentonite.⁸ A few specimens have been collected from the lowest Trenton limestones along Deer River west of Deer River village; the thickness of the beds that intervene above the Black River group cannot be determined because of lack of exposure, but would seem to exceed 30 feet. Though the species is present at 14 feet at Lowville, and abundant in the basal beds at Martinsburg, lack of exposure prevents the determination of the upper limit of its range in each section.

Countless specimens of *Triplecia cuspidata* occur in beds 12 feet and 17 feet above the base of the Trenton along House Creek, southwest of Glenfield. In limestones associated with these beds, the following species occur; see Table I:

TABLE I.

Upper Rockland faunule, House Creek, near Glenfield.

<i>Schizocrinus nodosus</i> Hall.....	c*	<i>Dalmanella rogata</i> (Sardeson) ..	a
<i>Batostoma winchelli</i> Ulrich.....	f	<i>Rafinesquina alternata</i> (Conrad)	c
<i>Bythopora</i> sp. cf. <i>B. allicornis</i>		<i>Sowerbyella curdsvillensis</i>	
Ulrich	f	(Foerste)	aa
<i>Escharopora</i> sp. cf. <i>E. subrecta</i>		<i>Triplecia cuspidata</i> (Hall).....	aa
Ulrich	c	<i>Calymene senaria</i> Hall.....	f
<i>Hallopora</i> sp. aff. <i>Halloporina</i>		<i>Encrinurus</i> sp.....	u
<i>crenulata</i> (Ulrich and Bassler)	c	<i>Lepidocoleus jamesi</i> (Hall and	
<i>Pachydictya acuta</i> (Hall).....	f	Whitfield)	f
<i>Prasopora</i> sp. cf. <i>P. simulatrix</i>		<i>Schmidtella</i> sp.....	c
Ulrich	f		
<i>Rhynidictya</i> sp.	f		

⁷ Wilson, Alice E., The Range of Certain Lower Ordovician Faunas of the Ottawa Valley, Geol. Survey, Canada, Museum Bull. 33, 42, 1921.

⁸ Kay, G. Marshall, Stratigraphy of the Ordovician Hounsfield Metabentonite, Jour. Geol., 39, 363, 1931.

* The following abbreviations are used in referring to the abundance of the fossils: "aa," very abundant; "a," abundant; "c," common; "f," frequent; "u," uncommon; "r," rare.

Other Rockland faunules have been listed by Coryell from Lowville,⁹ and by Clark from Martinsburg.¹⁰

Specimens of *Triplecia cuspidata* are abundant in beds between 15 and 20 feet above the base of the Trenton along Douglas Creek, and in the lower 18 feet of the section beneath the New York Central Railroad bridge over Sugar River south of Denley station. At "The Ledges" along Black River within a mile above the bridge 2 miles northeast of Boonville, Oneida County, the species is abundant in a bed 9 feet above the Black River limestone, and occurs in the succeeding 9 feet of beds. Near Middleville, 25 miles to the southeast, Trenton limestones younger than Rockland, and containing a thin metabentonite bed, lie disconformably on the Lowville limestone.¹¹

The thickness of the Rockland formation reaches 55 feet west of Watertown, and decreases to less than 20 feet 60 miles to the southeast of the westernmost New York exposure. The decrease in thickness seems due to the loss of lower Rockland beds in the overlap of the Trenton group on the Black River group. There is an unconformity between the Black River and Trenton groups in northwestern New York. The relationship is demonstrated because the southeastern sections are nearer to the center of the dome, and were thus exposed at times when the seas were covering more peripheral localities.

STRATIGRAPHIC RELATIONS OF THE UPPERMOST TRENTON LIMESTONE AND UTICA SHALE.

The contact of the Trenton limestone and overlying Trenton Utica black shale follows the west side of a broad terrace extending from northwest of Boonville in Oneida County across Lewis County through West Martinsburg into Jefferson County north of Copenhagen; see Fig. 2. It then follows the North Branch of Sandy Creek through Whitesville and Rodman to the base of the bluffs 2 miles east of Adams.

In Ontario, the uppermost limestones of the Trenton group

⁹ Coryell, H. N., A study of the Collections from the Trenton and Black River Formations of New York, Indiana Acad. Sci., Proc. for 1915, 263, 1916.

¹⁰ Clark, T. H., op. cit., p. 6.

¹¹ Kay, G. Marshall, Stratigraphy of the Ordovician Hounsfield Metabentonite, Jour. Geol., 39, 365, fig. 2; the caption of the picture is erroneous.

are the Lower Cobourg and Upper Cobourg formations, which have their type locality a hundred miles west of Adams in Northumberland County, Ontario, though they are well exposed in Prince Edward County, 50 miles away. In New York the top of the Lower Cobourg has been considered to be the uppermost bed in which *Rafinesquina deltoidea* (Conrad)¹² or the associated *Dinorthis iphigenia* (Billings) occurs in abundance; these species are rarely found in adjacent formations.

Section along Gulf Stream. Rodman. A continuous exposure of 36 feet of Upper Cobourg limestone beneath Utica shale occurs along Gulf Stream, above the bridge just east of Rodman, Jefferson County, New York; see Table II.

The section on Gulf Stream has 36 feet of Upper Cobourg limestone in exposed contact with the black Utica shale. The presence of *Ogygites* sp. in the upper beds would seem to indicate that the top of the Upper Cobourg is present, for *Ogygites latimarginatus* (Hall) is a guide fossil of the succeeding Collingwood formation in Ontario. The precise thickness of the Upper Cobourg formation cannot be determined at Rodman because there is no section with continuous exposure from the top of the Lower Cobourg to the beds at the base of the Gulf Stream section. The thickness can be estimated after consideration of the Copenhagen section, 14 miles to the east.

The black Utica shale lies with disconformity on the limestone. The shallowing of the water with subsequent withdrawal is suggested by the more nodular character of the upper 5 feet of the limestone, with intercalated undulating shaly seams, and a topmost bed that is frequently a limestone conglomerate. There seems to have been little or no erosion during the hiatus, and the basal bed of shale is of quite the same lithology as the succeeding beds, none of them containing

¹² *Strophomena deltoidea* Conrad, 1839, genotype of *Playfairia* Reed, 1917 (Trans. Royal Soc. Edinburgh, 51, 866), does not have the "interior of the pedicle valve with small subcircular or subpentagonal muscle-scar, about one-fourth the length of the valve" attributed to the subgenus and characterizing the misidentified *Rafinesquina* (*Playfairia*) *deltoidea* (Conrad) Reed, but a much larger one similar to that in other species of *Rafinesquina*; *Playfairia deltoidea* Reed is thus not congeneric with the genotype, *Playfairia deltoidea* (Conrad) which species in character of pedicle muscle scar seems congeneric with *Rafinesquina* Hall and Clarke, 1892, *sensu stricto*.

For the misidentified species, Reed offers the specific name *girvanensis*, the species becoming *Rafinesquina girvanensis* Reed = R. (*Playfairia deltoidea* Reed not Conrad, Trans. Royal Soc. Edinburgh, 51, 866; pl. 11, figs. 21-30, 1917.

TABLE II.

Section along Gulf Stream, Rodman.

TRENTON GROUP:	Thickness of Bed	Top of Bed to Base of Section
UTICA formation:		
Black, fine-textured, thin-bedded, fissile, clay-shale, with a good deal of fine quartz; containing <i>Triarthrus eatoni</i> (Hall) c; <i>Geisonoceras tenuistriatum</i> (Hall) c, and <i>Camarotoechia humilis</i> Ruedemann f; lowermost bed quite as those above (see Figure 3).		
UPPER COBOURG formation:		
Dark-gray, coarse-textured bed of limestone coquina, filled with fossil fragments, and with small rounded pebbles of black, fossiliferous limestone similar to that in underlying beds; to one inch in thickness; absent frequently; pyrite crystals and concretions also occur at this horizon.		
Black, fine-textured limestone in lensing beds with intercalated brittle shale; limestone unfossiliferous in hand specimen but showing many fossil fragments in thin section; passing imperceptibly into underlying beds; occasional specimens of orthoceracone cephalopods, <i>Isotelus</i> sp., and pygidia of <i>Ogygites</i> sp. cf. <i>O. latimarginatus</i> (Hall) about		
	5'	36'
Gray, fine-textured, argillaceous limestone, weathering to rubbly fragments, and containing occasional beds of coarse-textured limestone; faunule listed in Table 3.....		
	25'	31'
Three-inch bed of dark-gray, medium-textured, crystalline limestone filled with <i>Cyclospira bisulcata</i> (Emmons) a, <i>Sowerbyella minnesotensis</i> (Sardeson) aa, and <i>Leptelloidea gibbosa</i> (Winchell and Schuchert) f.....		
		6'
Beds similar to those above, to the base of the section at the ledge in the floor of the stream beneath the bridge		
	6'	

TABLE III.

Upper Cobourg faunule, upper beds along Gulf Stream.

<i>Mesotrypa</i> sp.....	u	<i>Hormotoma trentonensis</i> Ulrich	
<i>Crania trentonensis</i> Hall.....	r	and Scofield	c
<i>Cyclospira bisulcata</i> (Emmons) ..	r	<i>Liospira americana</i> (Billings) ..	f
<i>Lingula</i> sp.....	u	<i>Lophospira</i> sp. cf. <i>L. bicincta</i>	
<i>Platystrophia</i> sp. cf. <i>P. amoena</i>		(Hall)	u
McEwen	u	<i>Salpinostoma expansum</i> (Hall) ..	u
<i>Plectorthis</i> sp. cf. <i>P. trentonensis</i>		<i>Simulites</i> sp.....	f
Winchell and Schuchert	f	<i>Tetranoda bidorsata</i> (Hall).....	u
<i>Rafinesquina camerata</i> (Conrad)	c	<i>Trochonema umbilicatum</i> (Hall)	aa
<i>Schizocrania filosa</i> Hall.....	r	<i>Conularia trentonensis</i> Hall.....	r
<i>Sowerbyella</i> sp. cf. <i>S. minnesotensis</i>		<i>Tentaculites</i> sp.....	f
(Sardeson).....	f	<i>Orthoceras</i> sp.....	c
<i>Zygospira recurvirostris</i> (Hall)	la	<i>Isotelus gigas</i> Dekay.....	f
<i>Fusispira subfusiformis</i> (Hall)	f	Crinoid segments.....	f
<i>Hormotoma bellicincta</i> (Hall) ..	u		

any fragments of the underlying limestone; see Fig. 3. The contact may be seen to the east along Sandy Creek at a number of places; it is exposed for some distance along the stream east of Tylerville, where the contact is similar in character to that along Gulf Stream.

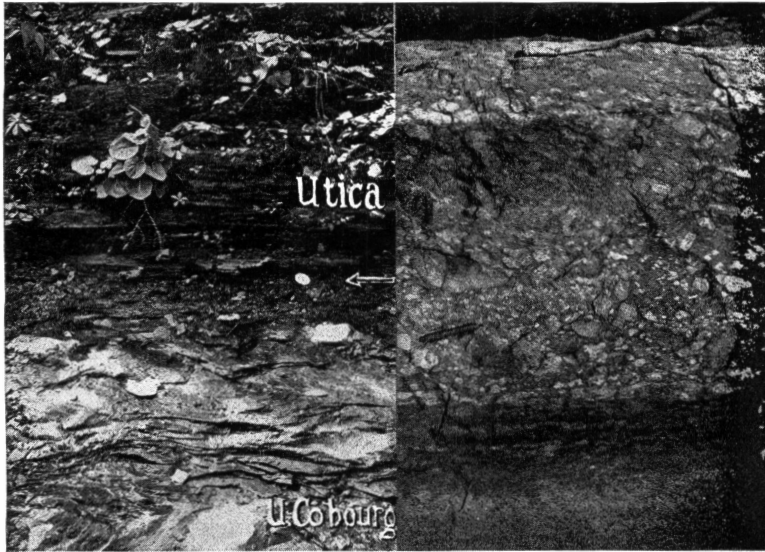


Fig. 3.

Fig. 4.

Fig. 3. Contact of Utica shale on Upper Cobourg limestone along Gulf Stream, east of Rodman. The half dollar lies on a pyrite band at the contact.

Fig. 4. Two-foot bed of limestone conglomerate with its base about 10 feet from the bottom of the Upper Cobourg formation on the east side of Deer River, Copenhagen.

Though the contact of the Utica (Deer River) black shale on the Upper Cobourg limestones is not exposed at Copenhagen, there is no appreciable gap in the section. There is no exposure of the contact in the Black River drainage basin to the southeast, and the most northerly in Oneida County is that at Westernville, described by Ruedemann¹³; this is distant about 45 miles from Tylerville.

Section at Copenhagen. Aside from the topmost beds, there is a complete exposure of the Upper Cobourg formation

¹³ Ruedemann, Rudolf, Utica and Lorraine Formations of New York, Part I, Stratigraphy, New York State Museum, Bull. 258, 44, 1925.

along Deer River at Copenhagen. The highest bed in which *Rafinesquina deltoidea* is abundant, near the top of the Lower Cobourg formation, is 3 feet 6 inches below the crest of the High Falls dam; occasional specimens of that species, and of *Dinorthis iphigenia* (Billings) occur in the succeeding 5 feet of limestones that comprise the top of the formation. The Upper Cobourg limestones are for the most part rather fine in texture, but there are intercalated crystalline beds that contain most of the faunules. The bed forming the lowest of the falls in the river below the mill includes limestone conglomerate where it is exposed along the east side of the stream near the quarry; limestone pebbles and cobbles of lithologies similar to the underlying beds lie in varying positions in a gray limestone matrix; see Fig. 4. At the same horizon on the opposite side of the river, there is a channel in the beds.

Fossils abound in a 6-inch bed of gray, crystalline limestone exposed in the bluff 50 yards downstream from the conglomerate exposure; the horizon is about 20 feet from the *Rafinesquina deltoidea* bed a few feet below the base of the formation; see Table IV.

TABLE IV.

Upper Cobourg faunule 20 feet, Deer River.

Crinoid stems.....	f	<i>Hormotoma trentonensis</i> Ulrich	
<i>Streptelasma</i> sp.....	c	and Scofield.....	f
<i>Mesotrypa</i> sp.....	u	<i>Trochonema umbilicatum</i> (Hall)	f
<i>Platystrophia</i> sp. cf. <i>P. extensa</i>		<i>Aparchites</i> sp.....	u
McEwan	u	<i>Calymene senaria</i> Hall.....	f
<i>Rafinesquina camerata</i> (Conrad)	aa	<i>Ceraurus</i> sp.....	u
<i>Rafinesquina</i> sp. cf. <i>R. robusta</i>		<i>Iliaenus americanus</i> (Billings) ..	u
Wilson	c	<i>Pterygometopus</i> sp.....	r

A 3-inch crystalline limestone filled with specimens of *Cyclospira bisulcata* is exposed at 44 feet, 11 feet above the most conspicuous bedding plane in the face of the quarry east of the river; the faunule is listed in Table V, as well as the species that occur at 48 feet in a bed of similar lithology.

TABLE V.

Upper Cobourg faunules, 44 and 48 feet, Deer River.

<i>Cyclospira bisulcata</i> (Emmons).....	44'	48'
<i>Dalmanella</i> sp. aff. <i>C. whittakeri</i> Raymond.....	a	r
<i>Plectorthis</i> sp.....		a
<i>Sowerbyella</i> sp. cf. <i>S. minnesotensis</i> (Sardeson).....	aa	f
<i>Rafinesquina camerata</i> (Conrad).....		c
<i>Trochonema</i> sp. cf. <i>T. umbilicatum</i> (Hall).....		c
<i>Isotelus</i> sp.	• f	r

The overlying 10 feet of limestones become more argillaceous and shaly in structure; *Trochonema umbilicatum* (Hall) and *Hormotoma trentonensis* Ulrich and Scofield are quite common.

The total thickness of the Upper Cobourg limestone on Deer River is 55 to 60 feet, the base being about five feet above the *Rafinesquina deltoidea* bed, and a few feet of top beds being unexposed; the *Cyclospira bisulcata* beds are at about 40 feet. If there be a similar thickness of beds beneath the *Cyclospira bisulcata* zone at Rodman, the thickness of the Upper Cobourg in that section is about 70 feet.

Sections in Lewis County. Along Atwater Brook, west of Martinsburg, the Lower Cobourg-Upper Cobourg contact is exposed a little more than a half mile below the Houseville-West Martinsburg road. *Dinorthis iphigenia* is a common fossil in a crystalline bed near the top of the Lower Cobourg; this same fauna has been recognized in the highest exposed beds along Mill Creek, a mile north of West Lowville, and along the north branch of Moose Creek, northwest of Boonville. The succeeding section is as in Table VI:

TABLE VI.

Section along Atwater Brook west of Martinsburg.

	Thickness of Beds	Top of Beds to Base of Upper Cobourg
LOWER UTICA formation:		
Black, fine-textured, thin-bedded, fissile clay shale; <i>Triarthrus eatoni</i> (Hall) and <i>Geisonoceras tenuistriatum</i> (Hall) particularly common; <i>Climacograptus typicalis</i> Hall present.		
Quarter-mile gap in exposure, probably representing about	15'	
UPPER COBOURG formation:		
Gray, rubbly limestones including a few thin conglomeratic beds	11'	16'
Gray, coarse-textured crinoidal limestone...	2'	5'
Conglomerate with fragments of fine-textured limestone, one of which had a specimen of <i>Rafinesquina deltoidea</i> ; reaching a maximum thickness of.....	3'	3'
LOWER COBOURG formation:		
Gray, fine-textured, rubbly limestone with some coarse-textured beds.....	5'	
Gray, coarse-textured, crystalline limestone, <i>Dinorthis iphigenia</i> the most common fossil.		

The Upper Cobourg thus has a thickness of somewhat over 20 feet in this section. In the Mill Creek, Lowville, and the

Moose Creek sections, beds with *Dinorthis iphigenia* occur at the top of beds in which *Rafinesquina deltoidea* is abundant; faunules collected from these two localities are represented in Table VII:

TABLE VII.

Lower Cobourg faunules, *Dinorthis iphigenia* beds, West Lowville (W. L.) and Moose Creek (M. C.).

	W. L.	M. C.		W. L.	M. C.
Crinoid stems.....	f	f	<i>Strophomena filitexta</i> (Hall)	f	
<i>Cyclospira</i> sp. cf. <i>C. bisulcata</i> (Emmons)		r	<i>Strophomena</i> sp.....	f	
<i>Dalmanella</i> sp. cf. <i>D. rogata</i> (Sardeson)	c	c	<i>Zygospira recurvirostris</i> (Hall).....		f
<i>Dinorthis iphigenia</i> (Billings)	c	f	<i>Orthodesma</i> (?) sp.....	r	
<i>Platystrophia</i> sp. cf. <i>P. longicardinalis</i> McEwan.....	c	a	<i>Liospira americana</i> (Billings).....		u
<i>Rafinesquina alternata</i> (Conrad).....		f	<i>Lophospira bicincta</i> (Hall).	f	
<i>Rafinesquina camerata</i> (Conrad).....	f		<i>Sinuities</i> (?) sp.....	f	
<i>Rafinesquina deltoidea</i> (Conrad).....	a	aa	<i>Tetranoda</i> sp.....		r
<i>Rafinesquina</i> sp.....		u	<i>Trochonema umbilicatum</i> (Hall).....	f	
<i>Sowerbyella</i> sp. cf. <i>S. minnesotensis</i> (Sardeson)....	a	a	<i>Ceraurus</i> sp.....	r	
			<i>Isotelus</i> sp.....	u	
			<i>Pterygometopus</i> sp.....		r

In the Westernville section, southwest of Boonville in Oneida County, the uppermost Trenton beds are of Lower Cobourg age, and *Dinorthis iphigenia* occurs in them.

The Upper Cobourg limestone, nearly 75 feet thick at Rodman and 60 feet at Copenhagen, thins to about 20 feet at Atwater Brook, and disappears within a few miles to the southeast. Lower Cobourg limestone lies beneath the Utica shale in the southeastern exposures. The sections are summarized in Fig. 5.

Interpretation of sections. Several interpretations of the relations of the Utica shales to the Trenton limestones may be presented; the subject has been discussed by Ruedemann.¹⁴

The thickening of the limestone in the direction in which the black shale thins is suggestive of there being replacing-overlap of the limestones by the shale to the northwest. If this were the case, the Utica shale would replacing-overlap the Upper Cobourg limestone, and the two would be contemporaneous.

¹⁴ Ruedemann, Rudolf, op. cit., 63.

The Utica shales exposed along the section are of Upper Utica age, though the presence of *Climacograptus typicalis* Hall in the basal beds warranted Ruedemann's assigning these beds with hesitation to the Lower Utica. The species, a guide fossil to the Lower Utica in the Mohawk Valley ranges through the lowest 60 feet of shales along Moose Creek. Middle Utica fossils are lacking, and the association of *Climacograptus typicalis* with the Upper Utica (Deer River) *Glossograptus timidus*, Ruedemann in the upper 40 feet of the range evidences the

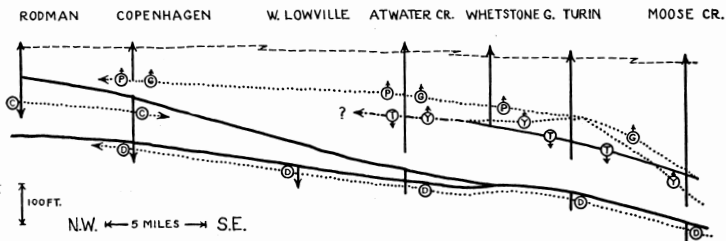


Fig. 5. Summary of sections of the Upper Trenton limestones and black shales in northwestern New York. C—*Cyclospira bisulcata* zone; D—*Dinorthis iphigenia* zone. Graptolite ranges after Ruedemann: G—base of *Glossograptus timidus*; P—base of *Climacograptus posterus*; Y—base of *Climacograptus pygmaeus*; T—top of *Climacograptus typicalis*.

continuous deposition of the beds, and confirms the assignment of all the shales to the Upper Utica. A contact is not exposed, but the underlying bed is the *Dinorthis iphigenia* bed at the top of the Lower Cobourg limestone. Thus the Upper Utica is younger than the Lower Cobourg; the late Collingwood-Gloucester age of the Upper Utica indicates an absence of the Upper Cobourg, which cannot be fully represented in the small unexposed interval.

At Atwater Brook, there are similar basal Upper Utica beds lying with a small unexposed interval on 20 feet of lowest Upper Cobourg limestone. *Climacograptus typicalis* is not present in the basal faunules on Deer River, though it might occur in the 20 foot unexposed interval above the underlying limestones of the high Upper Cobourg. At Tylerville and Rodman, where there is a disconformable contact of the limestone and shale, the lower shales have yielded no graptolites, but are presumably of Upper Utica age. An hiatus representing a part of the Collingwood thus separates the Upper Utica from the top of the Upper Cobourg.

The lithology of the uppermost limestones is not suggestive of replacing-overlap. In none of the sections is the upper limestone of black, argillaceous character, nor are there intercalations of black shale such as one might anticipate if the beds were deposited in waters continuous with nearby localities in which fine-textured shales were being laid down. The upper limestones seem to evidence shallowing of the water preceding a withdrawal of the sea that occurred prior to the deposition of the black shale.

Granting that the evidence does not warrant the interpretation of the relations in northwestern New York as those of replacing-overlap, another interpretation is suggested. The Upper Cobourg evidently disappears a few miles southeast of Atwater Brook; and there seems to have been an offlap of this formation to the northwest along the section. If fine clastic sediments were being deposited contemporaneously in the Mohawk Valley region, as seems probable, the southwestward extension of Adirondackia toward Rome seems to have prevented their reaching the Upper Cobourg embayment of western Adirondackia. The fact that the offlap is displayed along the section is due to the line of the section's being not tangential to Cobourg shorelines, but transgressing progressively farther on to Adirondackia toward the southeast.

There remains the interpretation of the thinning of the Upper Utica black shale in a direction along the section opposite to that of the thinning of the limestone. The magnitude of this thinning is accentuated when it is considered that the uppermost black shales in the northwest seem to be equivalent to the lowest sandy shales of the Frankfort group toward the southeast, the Atwater Creek arenaceous shales. There is no evidence of northwestward overlap along the section, though there is likewise nothing to prove that some is not present. The most of the thinning is presumably due to a convergence of beds as they become more distant from the source of clastic sediments, which seems to have been Appalachia to the east of the Mohawk Valley region. The Upper Utica sea seems to have overlapped so that its extent was greater than that of the Upper Cobourg, and the presumably equivalent older Utica beds of the Mohawk Valley.

The interpretation that seems to explain best the sections in northwestern New York is one of an Upper Cobourg offlap,

followed a little later by overlap in later Collingwood and Gloucester time with deposition of the Upper Utica shale.

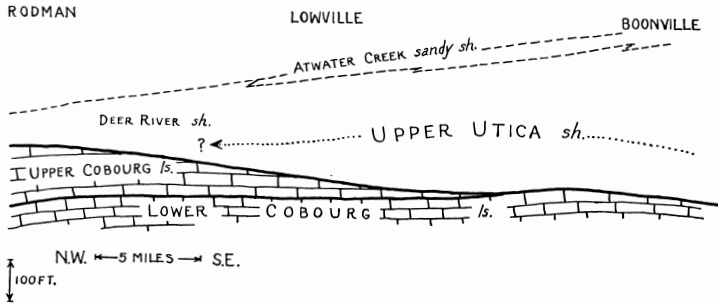


Fig. 6. Diagrammatic section to show interpretation of relations of uppermost Trenton limestones and black shales in northwestern New York; compare with Fig. 5.

Figures 6 and 7 illustrate the relations of the beds according to this interpretation. There was a withdrawal of the sea and

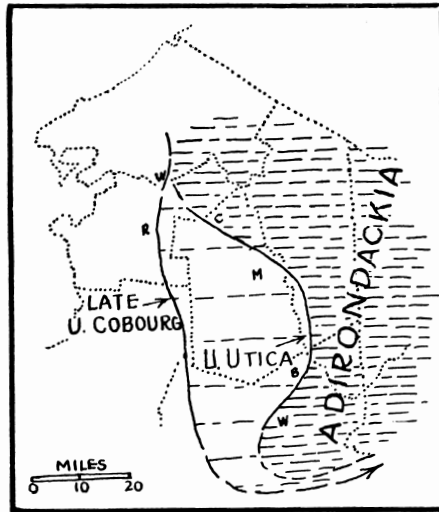


Fig. 7. Map of northwestern New York illustrating advance of Upper Utica sea beyond shore line of the late Upper Cobourg; see Fig. 2.

a readvance within late Trenton time, if the Collingwood and Gloucester be classified as Trenton.

HULL, SHERMAN FALL AND LOWER COBOURG FORMATIONS.

The stratigraphy of the intervening Trenton limestones younger than the Rockland and older than the Upper Cobourg has not been detailed. Their thicknesses have been determined by hand level along Deer River as totalling about 400 feet. There is continuous exposure in this section except below the bridge above Kings Falls, where the interval is difficult to estimate because there is folding with but few exposures.

The Hull extends from the top of the Rockland, about fifteen feet from the base of the exposed Trenton section along the stream, to about the top of Kings Falls, comprising a thickness of approximately 100 feet. The Sherman Fall is present at least to the power house below High Falls, Copenhagen, the beds at this point containing ostracoda similar to those in the Sherman Fall formation in the Lake Simcoe region, Ontario; the thickness is thus more than 125 feet. The Lower Cobourg continues to about the crest of the dam above the falls; the thickness is thus less than 175 feet. The total maximum thickness of the Trenton limestones in northwestern New York would seem to be about 535 feet.

SUMMARY.

In northwestern New York, the Rockland formation at the base of the Trenton group lies with disconformity on the Watertown limestone at the top of the Black River group; there is overlap of the Rockland toward the southeast along the outcrop so that there is a decrease of about 35 feet in its thickness. The uppermost limestones of the Trenton are the Lower Cobourg in the southern part of the outcrop, but successive beds of the Upper Cobourg limestone appear to the northwest by offlap, the formation reaching a thickness of about 70 feet at Rodman. The relations of the lower and upper limestone formations thus account for an increase in the thickness of the Trenton group of about a hundred feet near Lake Ontario as compared with that at Boonville.

The beds that overlie the limestones are the black shales of the Utica. Evidently these clastic sediments overlapped the Trenton limestones in Collingwood and Gloucester time.

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