CONTACTS OF THE WINDOM MEMBER (MOSCOW FORMATION) IN ERIE COUNTY, NEW YORK

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INTRODUCTION

Since the time of Cooper's (1930) survey of the Hamilton Group in New York State, it has been well established that the stratigraphic sections exposed in Erie County are relatively incomplete compared to the section in Central New York, particularly in the upper Hamilton Group. Clastic sediments derived from highlands to the east often failed to reach western New York. Thus, thin lag deposit limestones and scoured contacts between members or individual beds may be time equivalent to thick sequences of shales and siltstones in the east.

In western New York the Windom Member of the Moscow Formation is bounded above and below by unconformities representing two fairly major periods of nondeposition. Careful examination of the contacts provides evidence that these were also periods of erosion suggesting local shoaling of the seas. These discomformities are described in some detail in the present paper because of their implications in the interpretation of the depositional environments of the Moscow and overlying (Upper Devonian) Genesee Formation.

The study area covered in this report (Fig. 1) includes all outcrops form Cazenovia Creek at Spring Brook (Orchard Park 7.5 min. quad.) to Pike Creek near Derby, NY (Eden 7.5 min quad.) a total distance of about 20 miles.

LUDLOWVILLE/MOSCOW DISCONFORMITY

Stratigraphy

In New York the Moscow Formation (Hall, 1939) comprises the fourth and youngest formation of the Middle Devonian Hamilton Group. In western New York it consists of 10 to 150 ft. of calcareous, medium-grey shales and thin limestones. Cooper (1930) recognized three members of the Moscow in the Genesee Valley (Fig. 2): (1 ft.), basal Menteth Limestone, about 80 ft. of fossiliferous bluish-grey, calcareous Kashong Shale, and some 50 ft. of medium-grey, fossiliferous Windom Shale. The basal Menteth and Kashong Members thin rapidly westward and pinch out in Erie County. The Menteth can be traced west to Buffalo Creek at Bullis Road, whereas, the Kashong diminishes in thickness to about 16 in. at Cazenovia Creek in Spring Brook, N.Y. to an irregularly bedded mass of calcareous shale and argillaceous limestome packed with crinoid columnals and the branching tabulate coral Trachypora romingeri.

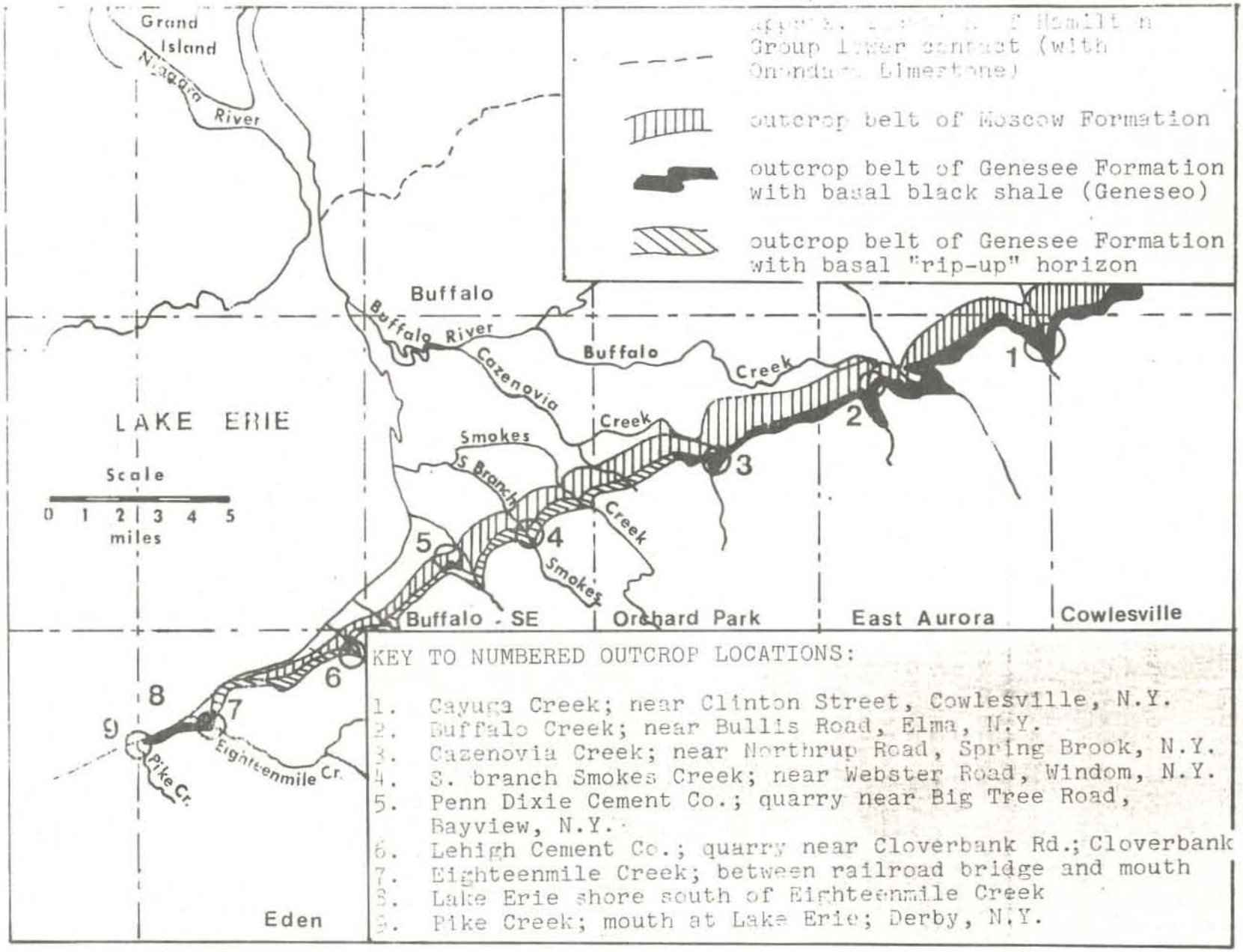
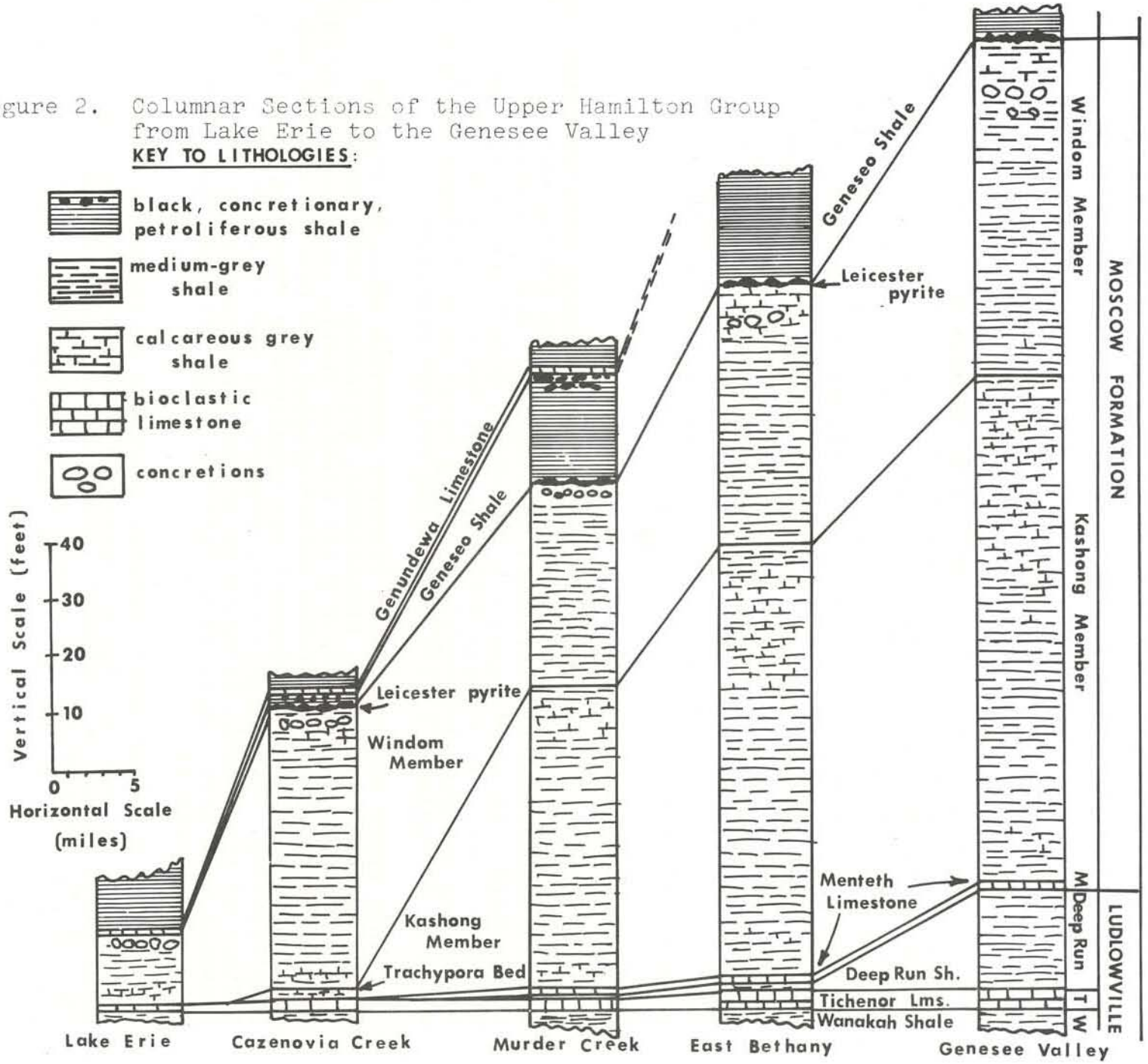


Figure 1. Location and prominent outcrops of Upper Hamilton and Genesee contact in Erie County, New York

Figure 2. Columnar Sections of the Upper Hamilton Group from Lake Erie to the Genesee Valley



data from Cooper, 1930

Two miles southwest of the Cazenovia Creek exposure, lenses of shaley limestone with the same fauna crop out in a small stream near Reserve Road. West of this locality the Moscow Formation is represented solely by the Windom Member which thins to 9 ft. on the Lake Erie shore. In exposures of Hamilton strata west of this, in Ontario and Ohio, Moscow equivalents are absent altogether.

In the Genesee Valley the Moscow is underlain by a thin layer (5 ft.) of Deep Run Shale, the uppermost member of the Ludlowville Formation in that region; but, the Deep Run also pinches out near Leroy in Genesee County. Thus, in all of Erie County, the Moscow Formation comes to rest on the next lowest Ludlowville unit, the Tichenor Limestone Member. Here the Ludlowville/Moscow contact is a disconformity representing the time-span during which portions of the upper Ludlowville and lower Moscow sediments were accumulating farther east. Careful examination of this contact has provided evidence for at least two (possibly more) periods of erosion during this time interval in western New York. At least part of the time the upper Tichenor surface was an exposed indurated hardground surface.

The Upper Tichenor Surface

At Cazenovia Creek where the calcareous Kashong shale overlies the Tichenor limestone, the upper contact between the two units, appears gradational and difficult to pinpoint. However, west of the Orchard Park quadrangle, the Kashong is absent and the Windom-Tichenor contact is sharply defined. Here the basal Windom shale containing abundant Ambocoelia umbonata rests on a Tichenor surface which is irregularly pitted suggesting erosive sculpture.

This upper portion of the Tichenor contains abundant fossils including numerous corals, brachiopods, bryozoans, and, locally large pelecypod valves. Nearly all bivalve shells are disarticulated; Many of the fossils are broken and/or abraded and burrows and borings are abundant. Thus, the deposit was considerably reworked prior to lithification. More significant, however, is the evidence that certain of the fossils lying in or on the upper surface of the Tichenor have been subjected to abrasion after the lime muds were indurated (Plate 1).

At the Tichenor upper surface, specimens of the larger, more robust fossils such as rugose corals and valves of the brachiopod Spinocyrtia granulosa frequently show differential abrasion. Exposed convex surfaces are often quite smooth and polished, whereas portions of the fossils imbedded wholly within the matrix of the Tichenor show considerable surface detail. On some of the large concavo-convex shells, protruding portions have been beveled off or faceted to nearly planar surfaces. Occasionally, the most convex central portions of the valves have been breached through entirely, exposing internal structures (Plate 1, Fig. 1.2).

Obviously, such extreme cases of faceting could only have developed on shells which were fixed rigidly in one position, as otherwise the valves would certainly have been plucked from the matrix by vigorous scouring of the bottom. Thus, during a period prior to the deposition of the Windom, the Tichenor sediments must have been partially or wholly indurated.

Encrustations of epifaunal organisms directly on the Tichenor upper surface provide additional evidence for induration of this surface. Rarely, crinoid holdfasts (Plate 1, Fig. 10) and inarticulate brachiopods are found to be attached to the surface of the Tichenor. A specimen of rugose coral, Heliophyllum halli was found in probable growth position (calyx facing upward) in the basal Windom shale at Eighteenmile Creek apparently cemented by its base to a shell fragment imbedded in the Tichenor (Plate 1, Fig. 8). The surface of this coral is only slightly worn and it was evidently preserved in situ rather than being reworked. Such organisms undoubtedly required firm substrates on which they could attach. It seems very unlikely that they would have cemented onto unstable crinoidal sand.

Basal "Conglomerate" of the Windom

In several localities the basal layers of the Windom contain reworked fossils and rock fragments from the underlying beds. No report of this zone has been made aside from a note by Grabau (1899) on the discovery of a "well-worn quartz pebble and a worn fragment of Spirifer granulosus, both of which were found in the lower part of the Moscow".

The reworked material is particularly common in section 5 of Eighteenmile Creek (Grabau's specimens came from this locality) where extremely worn fragments of fossils derived from the underlying Tichenor surface occur in association with well-preserved delicate shells of Ambocoelia, Choenetes, and other characteristic lower Windom species. Very smooth triangular fragments derived from halves of Spinocyrtia valves (Plate 1, Fig. 3,4) as well as worn pieces of rugose coral and crinoid stems, can often be recognized from this horizon. Rounded limestone pebbles, a few mm. to several cm. in diameter, with characteristic Tichenor lithology and fauna also occur within the basal Windom at this locality. They are evidently derived from the underlying scoured surface of the upper Tichenor and "incipient" pebbles can be seen on the Tichenor upper surface. These consist of rounded knobs of limestone which have been partially undercut. In some instances, Windom shale with Ambocoelia can be found filling in around such knobs, so their form was obviously produced prior to the deposition of the latter.

The limestone pebbles appear to be associated with shiny black phosphatic nodules 1 in. in maximum dimension) which are also common in the basal Windom in this locality. In some cases these nodules appear to be homogeneous, whereas others show a dark crust of phosphatic material around limestone pebbles or fossil fragments.

EXPLANATION OF PLATE 1: Fossils from the Tichenor Windom Contact.

1. Faceted specimen of Spinocyrtia granulosa, from the upper surface of the Tichenor Limestone at section of Eighteenmile Creek, Erie County, N.Y. xl.

2. a. b. Diagrammatic cross section of a brachiopod shell embedded in indurated rock demonstrating the way in which faceting takes place.

3. 7. Various typical reworked fragments from the basal Windom Shale at Eighteenmile Creek and the original skeletal elements from which they were derived.

3 & 4. Internal and external views of fragment derived from the pedicle valve of Spinocyrtia granulosa. xl

5. A bored, phosphatic steinkern from the cephalon of the trilobite Phacops rana x 1

6. Bored and rounded crinoid pluricolumnal xl

7. Fragment from a rugose coral xl

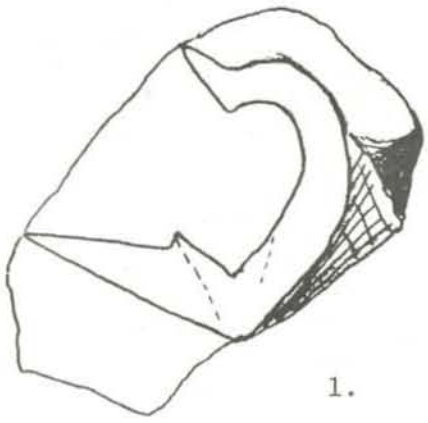
8-10. Attachments of epifaunal organisms, directly to limestone or pebbles.

8. Specimen of Heliophyllum halli found in growth position in the basal Windom Shale at Section Five, Eighteenmile Creek. The base of the coral was cemented to a shell fragment in the upper surface of the Tichenor Limestone. xl

9. Fenestellid bryozoan holdfast on a phosphatic pebble from the lower Windom Shale. x2

10. Scutella-type holdfast of crinoids on a pebble of Tichenor Limestone x2.

PLATE 1



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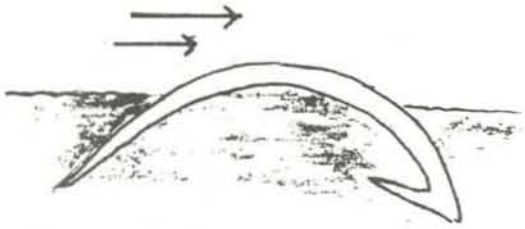

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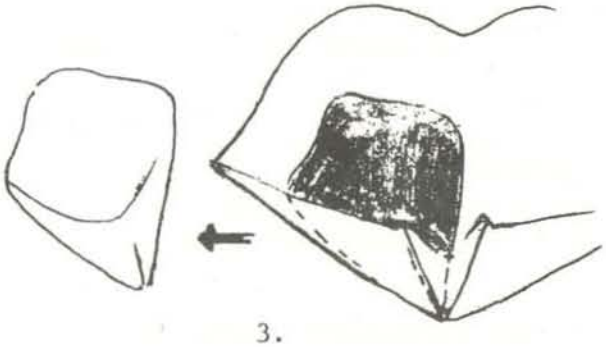

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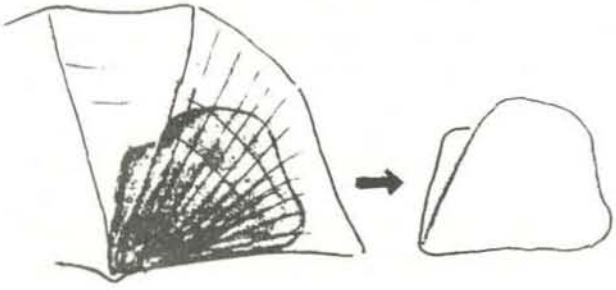

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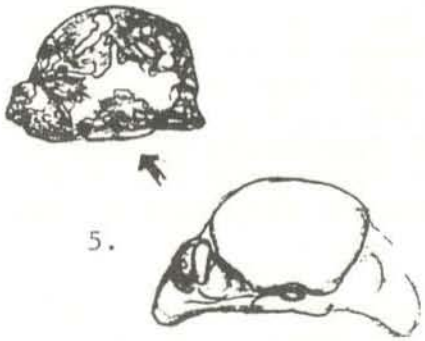

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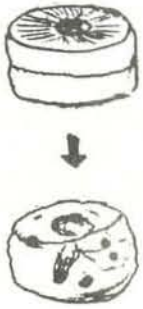

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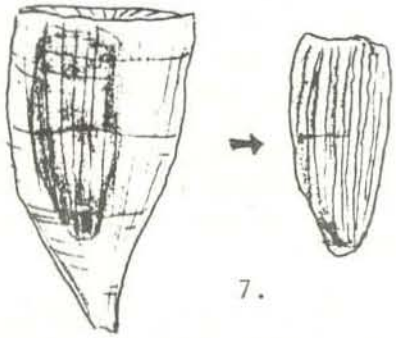

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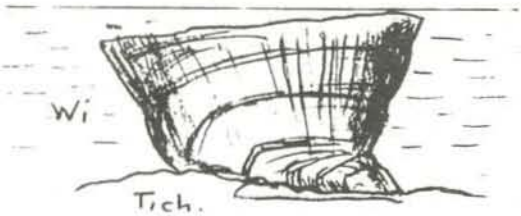

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Some fossils in the basal Windom also occur as phosphatic replacements. Brachiopods, including Tropidoleptus, Mucrospirifer, Camarotoechia, bellerophontid gastropods, fragments of trilobites, and bryozonas occur as internal molds, steinkerns of black phosphate. Most specimens lack surface details and may have originated as reworked Tichenor fossils. Others such as the bellerophontid gastropods are rather well preserved. As these are also forms which are not characteristic of either the Tichenor or the Windom, it can be speculated that they represent the remains of some otherwise unknown fauna which existed during the interval between the deposition of these two units.

Dietz, et al. (1942, p. 837) suggests that porous limestone may become replaced by phosphorite by infiltration with phosphatic solutions, "precipitation of phosphorite out of these solutions (could produce) a rock with a high percentage of phosphorite". The impure nature of some of the phosphatic nodules from the basal Windom suggests that these may have originated by replacement of Tichenor pebbles.

The phosphate nodules were themselves reworked for they are typically rounded and polished. Furthermore, they occasionally were bored. One phosphatic steinkern of a Phacops cephalon from Eighteenmile Creek shows a number of pits evidently produced by boring organisms (Plate 1, Fig. 5).

The assortment of limestone pebbles and phosphatic nodules which accumulated on the upper surface of the Tichenor provided hard substrates for the attachment of encrusting epizooites as did the surface of the limestone itself. The author has collected a piece of the lower Windom Shale from Eighteenmile Creek which contains a partial specimen of a fenestellid bryozoan with its holdfast cemented to one of the phosphatic pebbles (Plate 1, Fig. 9). A more spectacular specimen from the contact at Penn Dixie quarry near Bayview is a subangular, ellipsoidal limestone pebble 1.5 x 2.2 in. which shows eight minute crinoid holdfasts attached to its surface.

The basal reworked bed is not equally well developed in all localities, but at least a few worn fossils have been collected from the Ambocoelia bed in most outcrops. Secondary (derived) fossils in the lower Windom are not restricted to reworked Tichenor forms. At Cazenovia Creek where the Windom is underlain by the Trachypora bed" of the Kashong Member, reworked Trachypora specimens occur in the basal Ambocoelia bed. At Reserve Road where the Trachypora bed is very thin and lenticular, a mixture of Tichenor pebbles and Trachypora is found in the basal Windom. Phosphate nodules are very rare in these two localities, but occur abundantly at the Windom/Kashong contact farther east in Genesee County (discovered by Gordon Baird, University of Rochester).

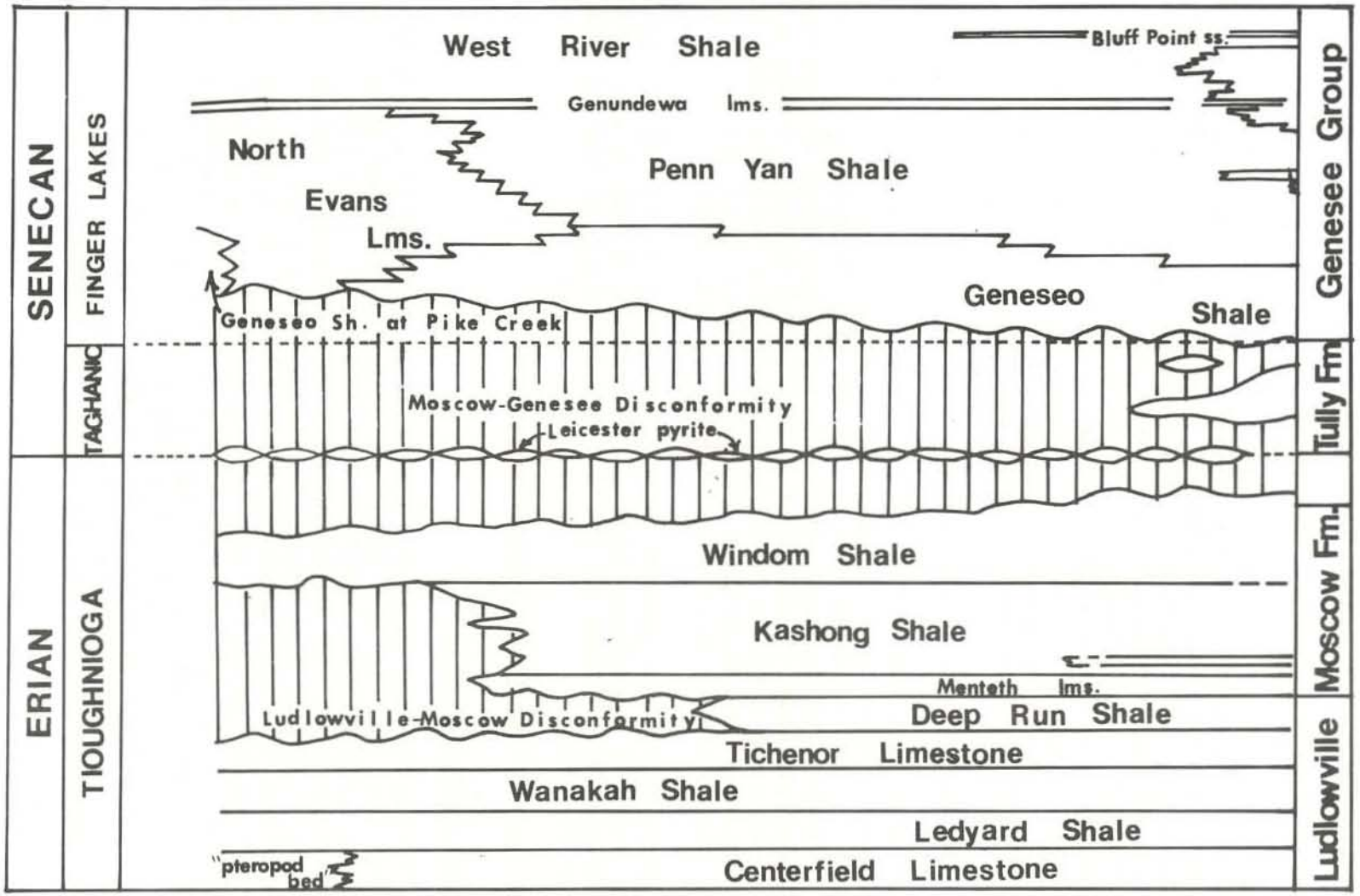


Fig. 3 - Stratigraphic relationships of the Upper Hamilton and Genesee in Western New York (adapted from Rickard, 1964)

Summary and Interpretation

During the interval of time between the deposition of the Tichenor and Windom sediments in western Erie County, the upper surface of the Tichenor became cemented to form an indurated hardground as is indicated by faceting of fossils, direct attachments of organisms, and pebbles in the overlying Windom shale. This hardground surface was exposed to shallow water above wave base. Pebbles of limestone were torn from the surface and slightly rounded by waves, holes were scoured in the upper surface (possibly initiated from solution of the rock), and fossils imbedded in the upper surface of the hardground were abraded and faceted. Limestone pebbles and fossil fragments torn from the limestone surface accumulated on the seafloor along with scattered fish plates and other debris. Phosphatic nodules may have formed by replacement of porous limestone, although in some cases, phosphatic material filled cavities within skeletal material.

The formation of the nodules probably occurred in quiet water where phosphatic solutions could concentrate. This seems to imply a period of deepening following the initial erosive phase. However the nodules were also reworked as they are generally smooth and rounded. Certain very smooth brachiopod fragments found in the lower Windom show traces of faceted surface also suggesting at least two periods of abrasion. Phosphate nodules found at the Windom-Kashong contact east of Erie County indicate that the second period of reworking may have occurred at least in part after the deposition of the Kashong in these areas.

Following the latest period of erosion, the water again deepened. A few benthic organisms such as fenestellid bryozoans, crinoids and rugose corals settled on pebbles or directly on the scoured surface of the Tichenor.

UPPER MOSCOW/GENESEE DISCONFORMITY

General Stratigraphy

Overlying the Moscow Formation in the central Finger Lakes area of New York is the massive, light-grey Tully Limestone which contains Late Middle Devonian (Taghanic) fossils (Fig. 4). At Canandaigua Lake the Tully pinches out abruptly and west of this locality rocks of the Taghanic Stage, if present at all, are represented by thin, discontinuous lenses of Leicester Pyrite (the Leicester actually may belong with the Upper Devonian Genesee Formation). In all of western New York from Canandaigua to Cazenovia Creek in Erie County, the basal black shales (Geneseo and Penn Yan Members) of the Upper Devonian overlie the Windom or the Leicester lenses when present. These units, like the underlying Moscow, show considerable westward thinning from about 80 ft. in the Genesee Valley to only 2 ft. at Cazenovia Creek. In Erie

County west of Cazenovia Creek, contrary to what is generally believed, the black Genesee shales and the Leicester pinch out entirely for a distance of nearly 20 miles along the outcrop belt. The Leicester may grade into the "Conodont bed" (North Evans Limestone), but the black shale reappears at the Lake Erie shore in the vicinity of Eighteenmile Creek (Fig. 5) and actually thickens in a southwesterly direction (opposite to most other units) in a short section along Lake Erie from Eighteenmile to Pike Creek.

Thus, in western New York, the upper contact of the Moscow Formation with the Genesee Formation represents another disconformity spanning all of late Middle Devonian and earliest Late Devonian time. Once again, in Erie County there is evidence for erosion as well as non-deposition during this interval. Particularly in the portion of the outcrop belt between Cazenovia and Eighteenmile Creeks, where the Geneseo and Leicester are missing. The basal Genesee "Conodont bed" contains abundant pebbles and shales of argillaceous limestone torn up form the underlying upper Windom Members. This "rip-up" zone and other evidence suggests that portions of the upper Moscow were truncated by erosion in western New York prior to the deposition of the Upper Devonian sedimentary units.

Description of Units

Several units of the Genesee Formation as well as the Windom Shale are involved in the Moscow/Genesee contact in Erie County. Because an understanding of the stratigraphic relationships is necessary for the interpretation of the disconformity, these units are briefly discussed in the following section. The upper Windom (Praeumbona bed) is described in a second paper in this guidebook by the author. In this paper the Genesee Formation is equivalent to the Genesee group of Rickard (1964).

Leicester Pyrite: Along most of the outcrop belt of the Moscow, the upper Windom is overlain by lenses of solid pyrite up to 6 in. thick containing a dwarf fauna of over 50 species, mainly brachiopods and pelecypods (Loomis, 1903)- the Leicester Pyrite. The bulk of this rock is made up of replaced crinoid columnals. Black fragments of bone and wood are also abundant.

This problematical unit has been correlated with the Tully Limestone (Cooper 1942), but the discovery of interbedded black shale within some lenses supports the view expressed by Hass (1959) and recently by Huddle (1974) that the Leicester represents replacement of a transgressive, basal lag concentrate of the Genesee Formation. The latter two authors also correlate the Leicester with the North Evans Limestone (or Genesee Conodont bed). This seems reasonable in view of the fact that the two have similar framework grains, "bone-bed" characteristics and lensatic nature. Furthermore, while the Leicester disappears west of Cazenovia Creek the North Evans can be traced from Lake Erie east to within four miles of the Cazenovia Creek in the same stratigraphic position.

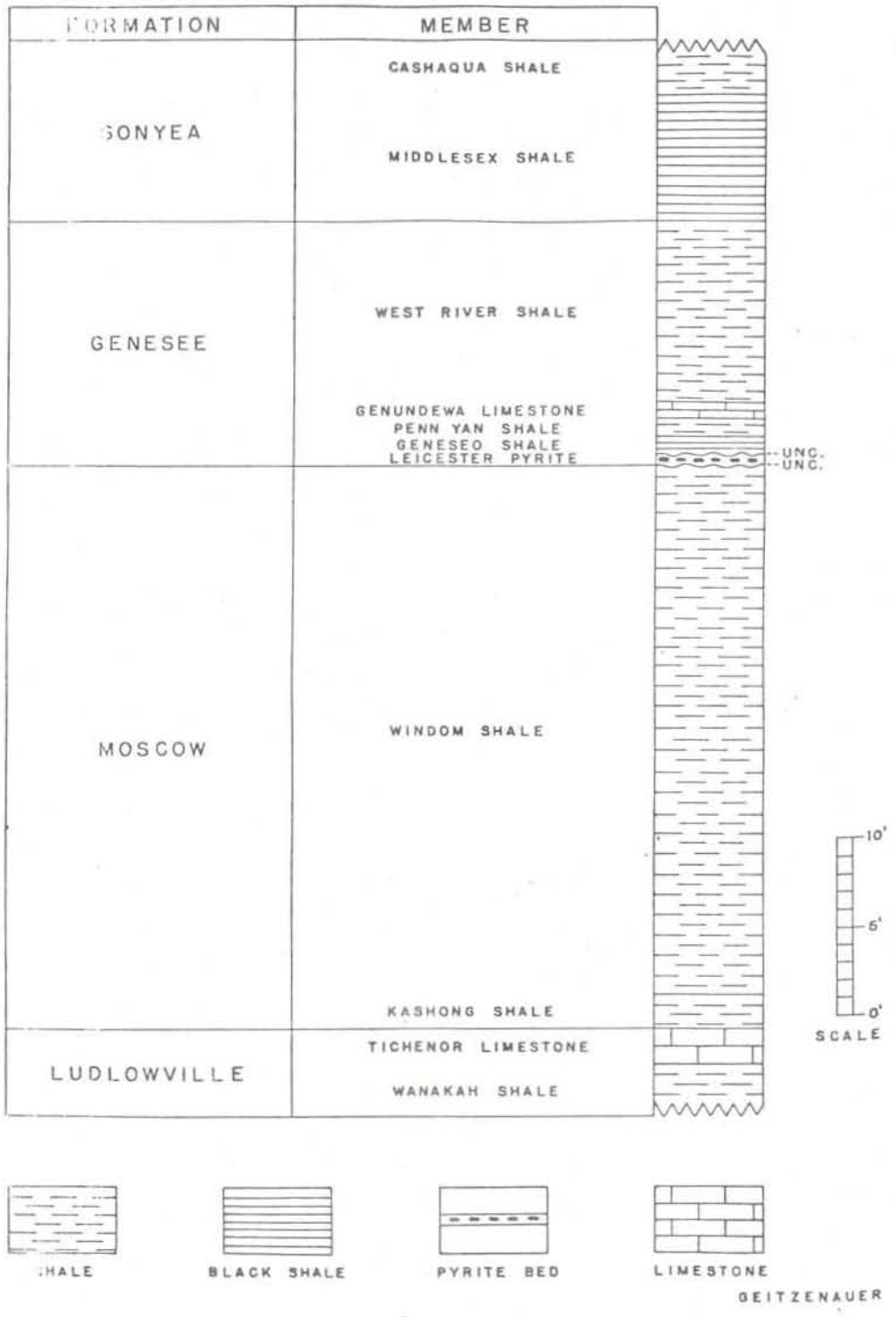


Fig. 4 - Stratigraphic column Tichenor-Middlesex (from Buehler and Tesmer, 1963)

North Evans Limestone Member: The name North Evans has been applied by and suggested by Wells (Rickard, 1964) for the thin (maximum 4") lensatic biocalcarenite occurring at the base of the Genesee Formation at Section 1 of Eighteenmile Creek near the town of North Evans. This lensatic bed which was formerly termed "Conodont bed" (Hinde, 1879) is well described by Hussakof and Bryant (1918, p. 12): "Lithologically, the 'Conodont bed' is an impure limestone containing large numbers of quartz grains, small pebbles, crinoid stems, fragments of fossil wood, and other matter. Here and there are fragments of pyrite and more or less broken remains of fishes and invertebrates." Buehler and Tesmer (1963) list 41 species of conodonts and 43 species of vertebrates including arthrodire plates, cladodid teeth and acanthodian spines. The density of conodonts in this limestone has been discussed by Bryant (1921) who reports that in places they make up nearly half of the rock.

The relationship of the North Evans Limestone to other stratigraphic units is somewhat obscure. The Devonian correlation chart (Rickard, 1964) shows the North Evans as a distinct unit, distinct from the Genundewa Limestone which directly overlies it in most sections of Eighteenmile Creek and time equivalent to the Geneseo and Penn Yan Members of the Genesee Formation farther east. Interbedding of typical "Conodont bed" lenses with black shale in section 5 of Eighteenmile Creek supports this interpretation. The author has traced the North Evans Limestone from its type locality northeast to the north branch of Smokes Creek near Orchard Park. The next exposure of the Moscow/Genesee contact is at Cazenovia Creek about 4 miles to the east. Here North Evans is apparently absent. However, a thin (0.5 in.), crinoidal layer rich in fish bones which coats the underside of the Genundewa limestone of this locality may be partly equivalent. At Pike Creek southwest of Eighteenmile Creek, the North Evans Member is represented by a persistant 0.5 in. crinoidal bone bed. This thin bed which is separated from the Genundewa Limestone by 9 in. of dark-chocolate-colored Geneseo shale is quite pyritic and suggests the Leicester although it is apparently not lensatic. Everywhere along its outcrop belt of about 20 miles, the North Evans lies directly on the Windom Shale Member. Near Pike Creek, the contact is flat, but elsewhere, the upper surface of the Windom appears to be highly eroded.

Geneseo and Penn Yan Shale Members: West of Cayuga Creek in Erie County the two lower shale members of the Genesee Formation are not distinguishable from one another (see Kirchgasser, 1973). At Cazenovia Creek the two members are represented by 2 ft. of black and dark-grey, unfossiliferous concretionary shale. These members do not appear in outcrops in the Buffalo Southeast Quadrangle nor in most of the Eden Quadrangle where the compressed lower Genesee sequence includes only the North Evans Limestone and about 6 in. of typical Genundewa Limestone. At section 1 of Eighteenmile Creek, thin (2 in.) tongues of black shale are interbedded with the North Evans member and separate this unit from the Genundewa. However, these tongues appear to pinch out when traced southwest along the creek exposures. Under the bridge of N.Y. 5 on Eighteenmile Creek a thin (2-3 in.), black shale layer again separates

the North Evans Member from the Genundewa. This appears to be continuous with the dark-chocolate bed at Pike Creek noted above. This unit, which was termed Penn Yan by deWitt and Colton (1939), can be traced for a distance of almost 2 miles along the shore of Lake Erie below Eighteenmile Creek and can be seen to thicken toward the southwest from 2 in. to 2 ft.

Genundewa Limestone Member: The Genundewa Member of the Genesee Formation is a dark, nodular, petroliferous limestone made up almost entirely of the minute shells of Styliolina fissurella, thus called the Styliolina bed by Grabau (1899). The Genundewa is about one foot in thickness at Cazenovia Creek where its undulating undersurface rests on dark concretions of the Geneseo-Penn Yan. Farther west the Genundewa is about 6-9 in. thick and generally rests with undulatory contact on the North Evans Limestone. In some localities such as at the Cloverbank Quarry, the contact between the two members is obscure. Whereas, at Eighteenmile Creek, thin shale partings may be present between the two. Elsewhere along the same exposure, the North Evans Limestone is present only as a thin veneer on the undersurface of the Genundewa.

The Genundewa appears to grade upward into the dark silty West River Shale in most exposures.

The Moscow Genesee Contact:

Huddle (1974) suggests that the western shore of the Tully sea may have stood near Canandaigua. If this is so, the remainder of western New York would have been as emergent area of exposed Windom muds. Whether or not this interpretation is correct, there is generally little direct evidence of erosion at the upper Windom surface. In most outcrops the Leicester or Geneseo paraconformably overlie the Windom. However, in western Erie County, there is abundant evidence of scouring of an indurated upper Windom surface.

Eroded upper Windom surfaces are best displayed in outcrops of the Windom Genesee contact in the Buffalo Southeast and Eden quadrangles, particularly in the Penn Dixie quarry at Bayview and the Lehigh quarry in Cloverbank. In all outcrops in these quadrangles from the north branch of Smokes Creek southwest to Eighteenmile Creek, the black Geneseo Shale is either missing or reduced to very thin discontinuous partings, and the Genundewa (Styliolina Limestone) rests directly on the North Evans (typical "Conodont bed").

The Windom North Evans contact in this section is highly irregular and may be characterized as a "rip-up" horizon. The Cloverbank exposure shows this feature very plainly (see Fieldtrip C discussion). Here slabs of the upper Windom argillaceous limestone 1 in. thick and up to 3 ft. across have been torn up and redeposited in the "Conodont bed" (North Evans). In a few instances, slabs of Windom, still partly bedded in the upper Windom, appear to bend up at one end into the overlying North Evans. Such slabs typically

Explanation of Plate 2. North Evans Contacts and "Rip up" Horizon. (all photos from Lehigh quarry at Cloverbank, N.Y.)

1. Upper and lower contacts of the North Evans Limestone (marked by arrows) note undulatory contact with Genundewa Limestone.

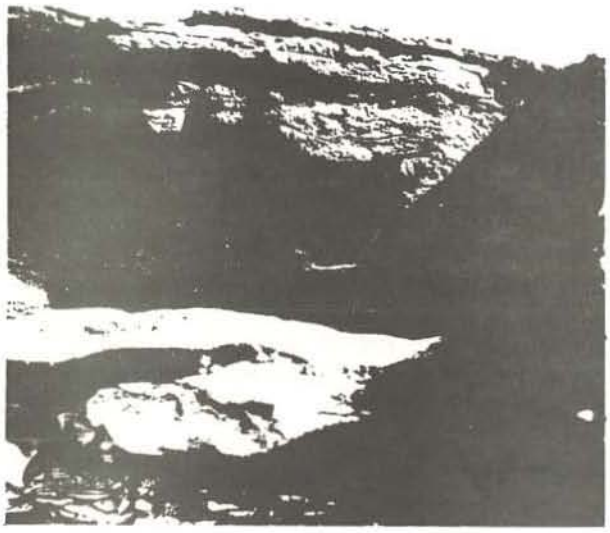
2. Characteristic "rip up" horizon showing both rounded and angular fragments of Windom argillaceous limestone incorporated into North Evans Limestone. (Conodont bed)

3. A fractured slab of Windom which bends up into the overlying North Evans.

4. Stacked slabs of Windom argillaceous limestone within the "Conodont bed.

5. Plan view of the underside of the North Evans showing incorporated concretionary limestone pebbles.

6. Windom/North Evans contact with a discontinuous layer of concretionary argillaceous limestone lying just below the "rip-up" horizon.



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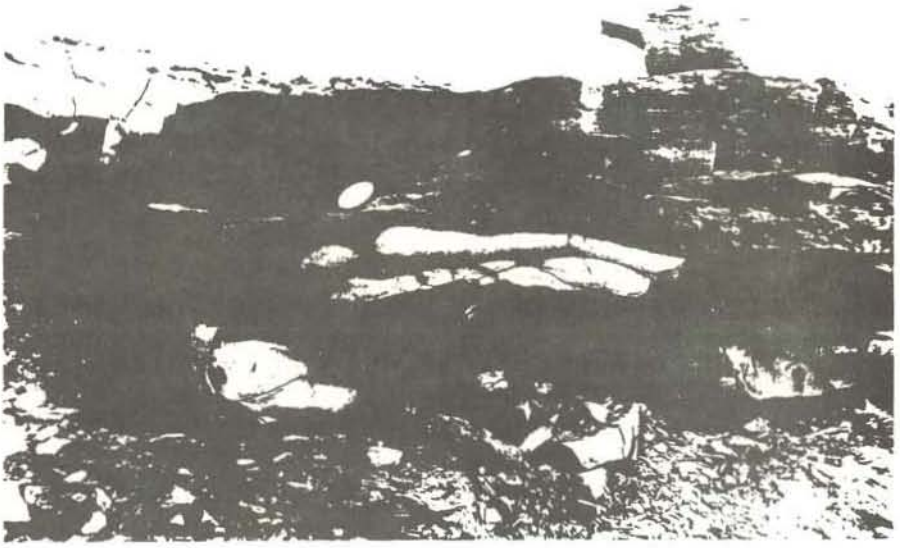

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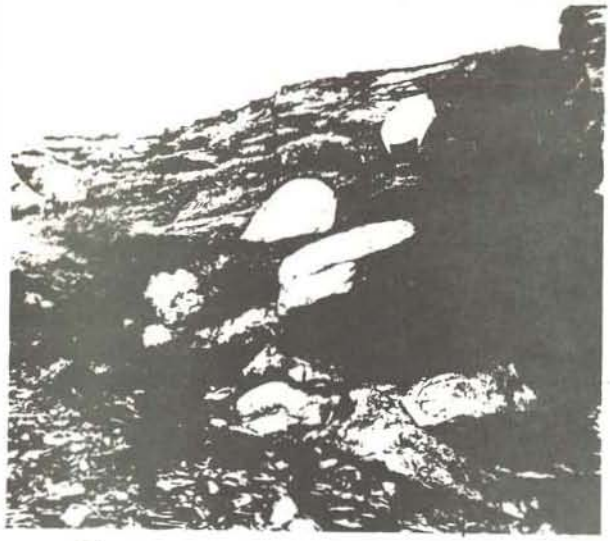

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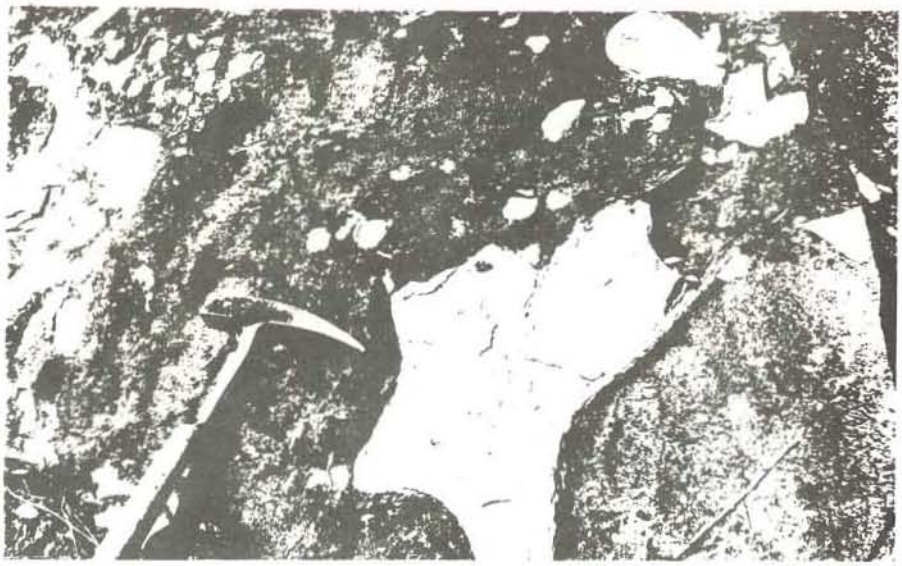

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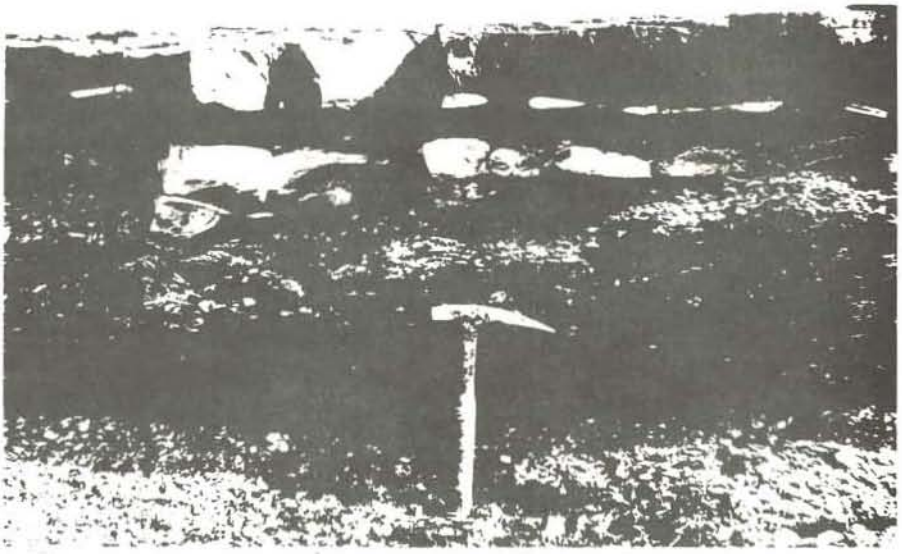


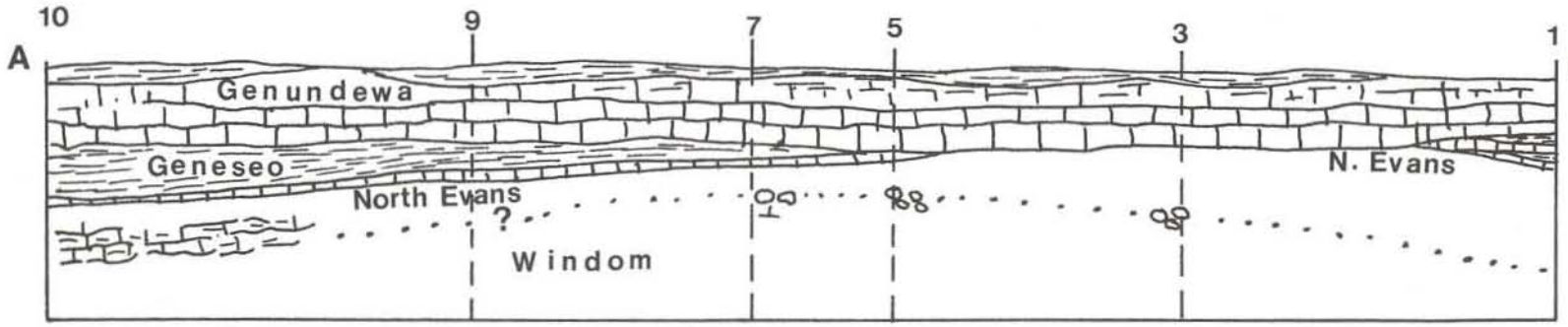
6

exhibit sharp angular breaks indicative of brittle fracture, and the fractures are usually filled with "Conodont bed" material. In some cases even the finest hairline cracks are "injected" with fine debris such as minute crinoid ossicles. The slabs of Windom are variously oriented and may be stacked one upon another. In contrast to the angular Windom slabs are subangular to rounded fragments, some of which probably represent reworked concretionary structures, while others generally overlying the angular fragments, appear definitely abraded and rounded by the action of water.

At Penn Dixie quarry the uppermost calcareous bed of Windom is rather fossiliferous, containing abundant brachiopods of which A. praeumbona is predominant. The overlying "Conodont bed" also contains numerous specimens of this species. Thin sections show the articulated valves of specimens of A. praeumbona with grey, micritic fillings which resembles the matrix of the underlying calcareous upper Windom suggesting that at least some of the fossils in the "Conodont bed" are reworked from the upper Windom. Specimens of typically Hamilton (Mid Devonian) fossils such as Atrypa reticularis, Mucrospirifer mucronatus, Mediospirifer audaculus, and undetermined rugose corals have been obtained from the Conodont bed in the "rip-up" horizon at Penn Dixie which also contains a mixture of "Middle and Upper Devonian conodont species (Huddle, 1974).

Truncation of the upper beds of the Windom is further indicated by tracing of persistant concretionary horizons below the contact. Gravau (1898) notes that a persistant double layer of concretions and shale containing the brachiopod Schizobolus truncatus can be traced along sections three and four of Eighteenmile Creek for a distance of about 500 ft. in each section (Fig. 5). The concretionary layer is about a foot below the Genesee contact in the southern ends of both sections and approaches the contact as it is traced northwesterly. Grabau concludes (1898, p. 23). "This layer therefore dips to the south at a higher angle than does the Styliolina limestone". A cross section (Fig. 5) constructed from measurements of the upper Windom and Genesee Formation at several exposures along Eighteenmile Creek similarly suggests the presence of a slight angular unconformity between the Moscow and Genesee at this location.

Detailed examination of exposures of the Moscow/Genesee contact in the vicinity of Eighteenmile Creek indicates that a complex series of depositional and erosional events took place at this surface in this area. Near the bridge of NY 5, the uppermost Windom is immediately overlain by a thin crinoidal-conodont bed about 1-2 in. thick, followed by 2 in. of black or chocolate-brown shale. There is little evidence of scouring at the base



KEY TO SYMBOLS:

- dark-grey to black, fissile petroliferous shale
- medium-grey, calcareous shale
- irregularly bedded, nodular, impure limestone (Styliolina)
- biocalcarenite; bone bed (Conodont bed)
- concretionary, argillaceous limestone
- probable position of a distinct, double layer of concretions in the Windom

Horizontal scale:

1 in.= 1960 ft.

Vertical scale:

1 in.= 2 ft.

KEY TO NUMBERED SECTIONS:

1-8 Grabau (1899)
9 cut on Lakeshore Road
10 Lake Erie cliff

Fig. 5. Cross section of the Moscow/Genesee contact in the vicinity of Eighteenmile Creek and index map showing the locations of the numbered sections.

of the North Evans and reworked Windom pebbles have not been found here. The North Evans here has roughly the same characteristics as the thin pyritic band which lies between the Windom and the 9 in. of black shale one mile farther south at the mouth of Pike Creek. Acetic acid residues have revealed similar conodont assemblages from both localities. Thus, if previous interpretations of the Pike Creek limestone band as Leicester are correct, it must be concluded that, at least in this last locality, "Conodont bed" is "Leicester pyrite".

At section 5 (Fig. 5) the black shale is reduced to a parting, or is absent, and here, and in all the exposures to the NY 5 bridge, the 'Conodont bed' occurs as a coating on the undersurface of the Genundewa Limestone, or is lacking altogether. Patches of crinoidal 'Conodont bed' on the underside of the Genundewa frequently contain rounded to subangular pebbles of light-grey, concretionary limestone evidently derived from the upper Windom. Smaller poorly-defined pebbles and chips of dark-chocolate-colored shale also occur within the crinoidal bone-bed martix. This suggests a tearing up of previous deposited, but still soft black shale and well-indurated upper Windom concretionary rock.

At section 1 of Eighteenmile Creek, where the North Evans limestone is interbedded with black shale, distinct fragments of 'Conodont bed' lithology can be found within the rock of a similar nature. These have evidently been scoured from previously deposited and partially cemented "Conodont bed". The thickness of the North Evans at its type locality may be related to "cannibalism" of nearby deposits of the same sediments.

Thus, along the Eighteenmile Creek a full spectrum of contact types is exhibited, ranging from paraconformable contact of the Windom with a layer of North Evans limestone to "rip-up" horizons with Windom and black shale pebbles and even reworked pebbles of "Conodont bed" within the North Evans.

Summary and Interpretation

A portion of western Erie County roughly delimited between the present Cazenovia and Eighteenmile Creeks was apparently subjected to greater erosion during the interval of Windom to North Evans than adjacent areas. The "rip-up" horizon characteristic of the Moscow Genesee contact in this area suggests scouring of a partially indurated and cracked, calcareous Windom muds. That such evidence of erosion is restricted in geographic extent suggests that a topographic high (possibly a localized island or arch) may have existed in this area.

Discovery of reworked Windom fossils in the North Evans, the "rip up" horizon and detailed tracing of distinctive upper Windom beds suggests truncation of portions of the upper Windom in this area by pre-North Evans erosion.

The contact in the Eighteenmile Creek area is complex. Dark Geneseo muds deposited in this region on top of a basal lag concentrate were locally scoured, torn up, and elsewhere were blanketed by reworked "Conodont bed" sands. West of this locality, conditions were similar to those existing east of Spring Brook, N.Y. where dark muds were probably gradually accumulating in quiet water, because there is little or no evidence of erosion.

Similarity of the Leicester pyrite lithology and its interbedding relationship to the black Geneseo shales suggests that it was formed under similar conditions to the thin North Evans layer at Eighteenmile Creek. The two units may in fact be stratigraphic equivalents.

Hassakof and Bryant (1918) interpreted the "Conodont bed" as a sandbar deposit citing as evidence, vague cross bedding, waterworn pebbles and wood fragments, and the mixture of marine and non-marine vertebrate fossils. Huddle (1964) similarly suggests that the North Evans is a transgressive lag deposit. These interpretations are in accord with observations of the Moscow Genesee contact in western Erie County.

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A special thanks to my wife Bettylou and my mother who helped in the preparation of the manuscript, and to Dr.'s Edward J. Buehler and G. Gordon Conally of SUNY, Buffalo who have given advice and encouragement for my independent studies of local paleontology.

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TRIP C - LATE MIDDLE AND EARLY UPPER DEVONIAN DISCONFORMITIES AND PALEOECOLOGY OF THE MOSCOW FORMATION IN WESTERN ERIE COUNTY

Carlton E. Brett and Gordon Baird

Total Miles	Miles from last point	Route Description
		We will take the N.Y. Thruway to Exit 54 where the road log begins.
0.0	0.0	Take Exit 54 for N.Y. Rt. 400. Turn right (west) onto exit for 400 south.
		BEGIN ROAD LOG WHERE THE EXIT RAMP MEETS THE AURORA EXPRESSWAY.
4.4	4.4	Exit for Transit Road south (N.Y. 78, U. S. 20). Turn right onto exit and bear southeast.
4.9	.5	Transit Road. Turn right (south) and proceed for a short distance.
5.2	.3	Intersection with N.Y. 16 (Seneca St.). Turn left (east) Town of Elma.
6.0	.8	Intersection with Northrup Road. Turn right (south)
6.2	.2	Bridge over Cazenovia Creek
		STOP 1. Cazenovia Creek at Northrup Rd., Spring Brook, N.Y. (Orchard Park 7.5 min. quad.): A good exposure of Ludlowville Moscow contact can be seen on the left bank just downstream from the bridge. A thick section of Tichenor Limestone with basal shaley layer containing large favositids is overlain by the Trachypora bed of the Kashong Member about 11-14 in. thick containing abundant crinoid columnals, the coral Trachypora, large pelecypods, and gastropods. The base of the Moscow is the contact between the Kashong and Tichenor. The Kashong-Windom contact is marked by a rusty layer containing abundant crinoidal debris and Ambocoelia umbonata with occasional reworked specimens of Trachypora from the

Total Miles	Miles from last point	Route Description
		underlying Kashong. About 74 in. of Ambocoelia beds are present in the lower Windom here followed by (inaccessable) ledges of the calcareous Spinatrypa and coral-trilobite beds. At the falls east of Northrup Road, the Tichenor lower contact with the fossiliferous Wanaka shale can also be seen. High cliffs which can be seen in the distance upstream from the falls exposes about 40 ft. of Windom capped by the black Genesee shales and Genundewa limestone. Continue southwest on Northrup Road.
7.2	1.0	Intersection of powerline which passes over the road. STOP 2. Proceed down dirt path on the left side of the road near utility poles. At the bottom turn left and walk to exposure on Cazenovia Creek bank. Here the upper Windom Shale is at water level, the Genundewa Limestone of the Genesee Formation forming a projecting ledge. About .1 mile downstream is a good exposure of the Moscow/Genesee contact. About 20 in. of black Geneseo shale separates the upper Windom (Praeumbona Beds) from the Genundewa. At intervals, lenses of Liecester Pyrite 0.5-6 in. thick occur at the contact. These are fossiliferous and contain an assemblage of diminutive brachiopods and mollusks. One lens along this section shows interbedding of the pyrite with black Geneseo shale. The basal layer of the Genundewa at this locality contains abundant, well-preserved fish bones. Return to Northrup and continue on Northrup southwest.
7.5	.3	Intersection of N.Y. 187 (Transit Road) turn right (north)
7.9	.4	Intersection of first road on the left side to U.S. 20 (sign to Silver Creek) Turn left (west).

Total Miles	Miles from last point	Route Description
8.0	.1	Intersection of U. S. 20 (Southwestern Blvd.); turn left (southwest)
	5.1	Bridge on U. S. 20 over Smokes Creek (Type locality of the Windom is north, downstream) Orchard Park Stadium on left side.
18.4	5.3	Intersection of Rogers Rd. Turn right (northwest)
18.8	.4	Intersection of Cloverbank Rd. Turn left (west)
19.5	.7	Intersection of railroad tracks. Turn left onto gravel driveway just before tracks.

STOP 3. Cloverbank Quarry. (Eden 7.5 min. quad.): Leased quarry of Lehigh Cement Co., on east side of Versailles-Pennsylvania R.R. tracks about .3 miles southwest of the intersection of the tracks and Clover Bank Road.

The Quarry walls about 50 ft. high expose the Upper Devonian Middlesex-Cashaqua Shale, floored mainly by the shaley upper contact of the Genudewa limestone and the West River shale. In a narrow pit the Genundewa is breached and a section extends down some 8-10 ft. to, or just below, the Praeumbona bed of the Windom shale. The Windom here is in contact with the North Evans Limestone and the contact is an erosion surface showing characteristic "rip-up" horizon. The uppermost Windom bed is a concretionary, calcareous, grey (1-3 in.) shale or argillaceous limestone. It appears to be unfossiliferous. The upper layer is undulating and pieces of this layer have been incorporated into the overlying North Evans as "slices" which appear to be cracked and torn up. Others occur as rounded chunks. The crinoidal debirs of the North Evans appears within cracks in the Windom upper layer as if injected. Some of the pieces of the upper Windom bed have greenish stains on the surface suggestive of glauconite. The North Evans contains much debris including abundant

Total Miles	Miles from last point	Route Description
		fish plates and teeth, phosphatic nodules, much pyrite (note rusty stains), and a few invertebrate fossils: crinoid plates and rugose corals. The Genundewa itself is only about 6 in. thick and quickly grades into a somewhat sandy shale (West River). It is in direct undulating contact with the underlying North Evans although in places this contact is obscure.
		Return to Cloverbank Road and turn left (west)
19.9	.4	Intersection N.Y. 5 (Lake Shore Rd.). Turn Left (southwest).
20.2	.3	Town of Wanakah. Type locality for the Wanakah shale (Ludlowville Formation).
21.4	1.2	Fork of N.Y. 5 and Lake Shore Rd. Continue straight on 5.
24.0	2.6	North Creek Road, proceed straight on 5 for a short distance.
24.3	.3	Private drive on left side just before the bridge of N.Y. 5 over Eighteenmile Creek. Turn left onto this drive. Please park at the turn around area near the end of the private drive. Walk down the dirt road to the bank of Eighteenmile Creek (Grabau's 1898 section 5 - see Fig. 5 in text).

Section 5

STOP 4. Eighteenmile Creek (Eden 7.5 min. quad.): About 1/4 mile south of the bridge at route 5 over Eighteenmile Creek, the creek makes a major U-bend and swings around from southwest to northeast. Due south from the bridge on the left side of the stream is a large meander scar, then the bank rises steeply where the stream is actively cutting into the Tichenor Limestone. Here the Tichenor forms a slightly undercut ledge about 1-2 ft. from the water edge, for about 1/4 mile to a small falls. The lower beds of the Windom Shale (here about 17 ft. thick) are easily studied here. The upper 1-3 ft. or so of the Wanakah which is exposed here is quite fossiliferous. The Tichenor is 1 foot thick, massive and contains abraded crinoid columnals and other fossils. Its upper surface is notably rich in the pelecypod Plethomytilus here, and contains traces of

Total Miles	Miles from last point	Route Description

burrows. At this locality a zone of shale about 3 in. thick in direct contact with upper Tichenor Limestone contains waterworn fragments of brachiopods (Spinocyrtia), limestone pebbles eroded from the underlying Tichenor, and rounded black pebbles (0.2-0.5 in.) probably phosphatic. A large crinoid root (scutella-form) was in place on the upper surface as well as bored and abraded shells. The lowest 2 ft. of the Windom contain the extremely rich Ambocoelia beds, and these are overlain by classically developed coral beds (3 in. thick) with large Cystiphylloides and the brachiopods Atrypa, Spinatrypa, followed by one foot of calcareous shale containing Amplexiphylloides, Stereolasma, Mucrospirifer consobrinus, and well-preserved trilobite remains. Poorly preserved Nuclulites are found in the middle of these shales and just a few inches above the "trilobite-coral" layer a few pyritized fossils (Bucanopsis and nautiloids) were obtained. Associated with these (just below) was a thin unfossiliferous, calcareous lens and above some Mediospirifer and corals were collected.

Most of the overlying shales are barren, although near the top, the slightly concretionary calcareous Praeumbona bed contains abundant brachiopods. The Genundewa Limestone overlies the Windom about 17 ft. above the Tichenor. Fallen blocks reveal a thin coating of "Conodont bed" adhering to the underside of the Genundewa. This unit contains pieces of upper Windom argillaceous limestone as well as dark shale pebbles.

The section is capped by about 20 ft. of Genesee Formation and massive jointed Middlesex black shale fallen blocks of the yield plant remains.

Section 4. Proceeding upstream from the falls at section 5, Eighteenmile Creek bends to the south. About 500 ft. above the falls a steep bank on the south (right) side of the creek exposes a section of some 75 ft. (Section 4). At the top of the bank the black Rhinestreet Shale (Upper Devonian, West Falls formation) forms a nearly vertical wall.

Total Miles	Miles from last point	Route Description
		Below it is the greenish-grey Cashaqua, blocky black Middlesex Shale (two members of the Sonyea formation), and a dark-grey West River Shale. The Genundewa limestone forms a projecting ledge at the base of the cliff. The "Conodont bed" (North Evans) is either missing or occurs as very thin patches on the underside of the ledge. A few feet of Windom crop out beneath the ledge. The creek is very deep next to this section and therefore it is difficult to examine in detail.
		Section 3. Opposite the upper end of section 4 the creek swings back north and cuts the end of a promontory on the north side of the channel. Here an easily accessible section of upper Windom to Cashaqua can be seen. Note the double concretionary layer in the upper Windom. The basal Genundewa has black shaley seams, but the "Conodont bed" is apparently absent here.
		Section 1. It time and creek conditions permit, we will proceed around the end of the promontory and upstream (east) about 500 ft. to exposures on the left bank near the trestle of N.Y. Central Railroad. Here in the type locality, the North Evans Limestone thickens to a maximum of about 4 in. In places, interbeds of dark shale separate the North Evans limestone into two bands. The unit is also separated from the overlying Genundewa by a black shale seam.
		Return to the bus via a dirt path running from the end of the promontory at section 3 to the end of Basswood Drive. Access to sections of Eighteenmile Creek from private lands has been provided by kind permission of the owners, Mr. S. Prahovic and Mr. W. F. McLimans. Please respect this privilege.
		Return to N.Y. Rt. 5 and turn left (southwest).
26.8	2.5	Intersection of Delamater Road. Turn left (south).

Total Miles	Miles from last point	Route Description
27.6	.5	Intersection of Derby-Sturgeon Pt. Rd. Turn left (east).
28.5	.9	Railroad crossing.
29.1	.6	Intersection of Versailles-Plank Rd. Turn right (south)
	1.3	Rt. 20. Go straight through this intersection.
30.9	.5	Intersection of Evans Ctr-Eden Rd. Turn left (east)
	.9	Proceed over Thruway to Interchange 57A.
32.2	.4	Thruway tollgate. Turn left. Proceed on ramp to Westbound lane of Thruway.
		Thruway to Fredonia.