

Frasnian (lower Upper Devonian) geology of western New York as seen along Eighteenmile Creek and Route 20A: submarine discontinuities, gravity flows, and mass extinction

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Road Log

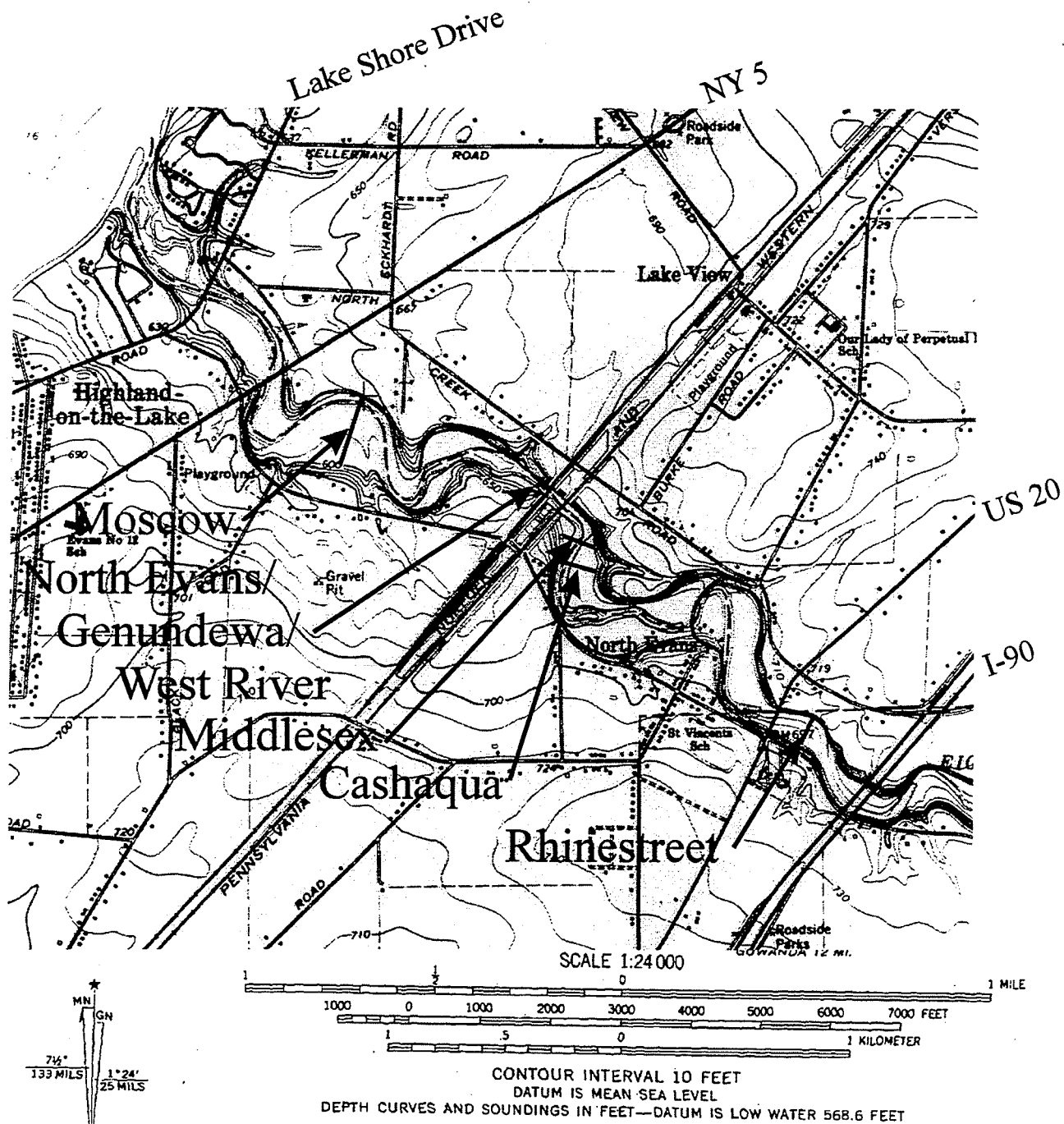
0.0	0.0	Begin at I-90 Angola Exit (Interchange 58), at the toll booth, 15 miles from SUNY-Fredonia. Turn right (northeast) on US 20 East toward Buffalo (Irving).
0.9	0.9	Cattaraugus Creek and Erie County, at signal proceed to right on US 20.
13.6	12.7	Turn left (northwest) on South Creek Road before crossing bridge over Eighteenmile Creek. Proceed through village of North Evans.
14.6	1.0	Cross under railroad overpasses and park in gravel pull-off. This is a popular fishing access site. Proceed northeast on the abandoned railroad grade under power lines to the path on the right which leads down to the creek.

Stop 1 – Eighteenmile Creek between NY 5 and North Evans, Erie Co., NY. Tichenor Limestone and Windom Shale of the Hamilton Group; North Evans Limestone, Penn Yan Shale, Genundewa Limestone, and West River Shale of the Genesee Group; and Middlesex Shale and Cashaqua Shale of the Sonyea Group.

The gorge of Eighteenmile Creek, formed by the resistant cliff forming Rhinestreet Shale of the West Falls Group, exposes Givetian (Middle Devonian) and Frasnian (Upper Devonian) strata that can also be seen on the shore of Lake Erie. North of the stone railroad bridge to the mouth of the creek the upper Hamilton Group and Genesee Group strata are exposed (Figure 1).

The oldest unit exposed along Eighteenmile Creek is the Wanakah Shale Member of the Ludlowville Formation (Figure 2). The Wanakah consists of soft fossiliferous medium gray calcareous shale. Decimeter scale cycles within the Wanakah record facies and sea level shifts (Batt, 1996; Batt, 1999, herein).

The Tichenor Limestone (“Encrinal Limestone” of Grabau, 1899) rests disconformably on the Wanakah Shale and marks the base of the Moscow Formation. The base of the Tichenor is sharp and irregular, characterized by prod marks and hypichnial burrows. This erosion surface is a cut down that includes over 5 m of strata present to the east in the Genesee River Valley (Figure 3a). The Tichenor at Eighteenmile Creek is a 30 to 40 cm thick medium to pinkish gray pyritic biowackestone-grainstone. It contains reworked pyrite and shells from the Ludlowville, as well as large rugose corals, favositids, crinoid columnals, brachiopods, trilobites, and bivalves. The top of the Tichenor is also disconformable, representing a submarine hard ground surface with crinoid holdfasts, encrusting corals, and mineral crusts of phosphate and pyrite. Key taxa visible on the upper surface of the Tichenor include large rugose corals and *Favosites*, numerous brachiopods including: *Spinocyrtia granulosa*, *Orthospirifer marcyi*, *Mediospirifer audaculus*, *Pustulatia pustulosa*, and *Elthyra fimbriata*. Also present are the bivalves *Plethomytilus* and *Actinopteria*, platyteratid gastropods, and large trilobites of the genus *Phacops*. Immediately



UTM GRID AND 1965 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Figure 1. Topographic map of lower Eighteenmile Creek (Eden, NY 71/2' Quadrangle) showing base of formations at creek level. The upper Moscow through Rhinestreet are exposed in the high cliffs of the creek north of the rail road bridges.

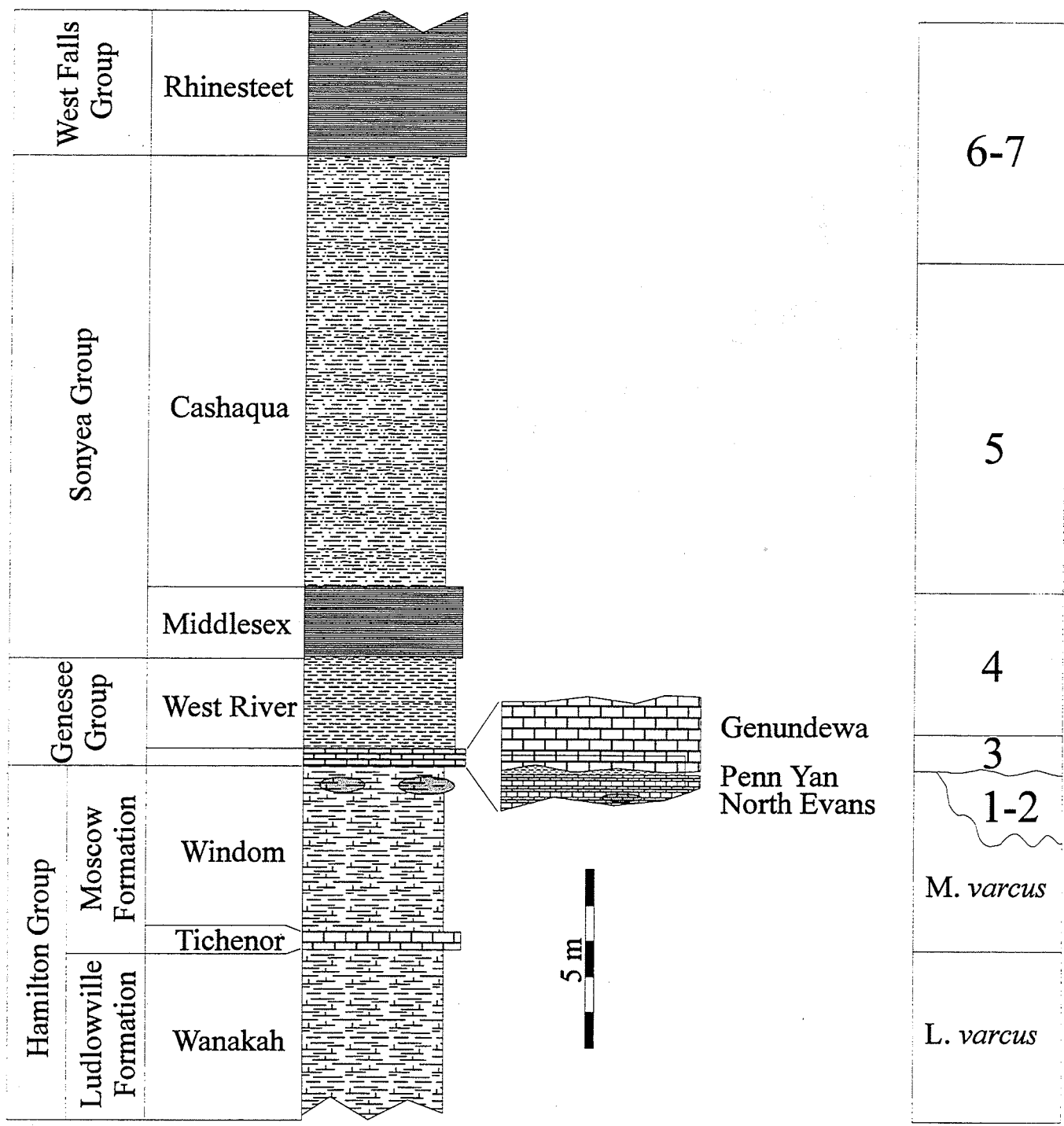


Figure 2. Schematic lithologic section and conodont zonation of Middle and Upper Devonian strata exposed along Eighteenmile Creek between NY 5 and US 20.

above the Tichenor is a thin (6 cm-thick) bed believed to be a condensed erosional remnant of the Kashong Shale Member, which can easily be confused as part of the Tichenor. This bed yields *Tropidoleptus carniatus* in association with *Spinocyrtia* and *Orthospirifer*.

Above the Tichenor and condensed Kashong Shale is the Windom Shale Member of the Moscow Formation. The Windom is 4.3 m thick along Eighteenmile Creek, bounded by discontinuities (Figure 3b; Baird and Brett, 1986), consisting of soft fossiliferous medium to dark gray calcareous shale, calcareous mudstone, and muddy carbonates. Soft shale at the base, with an abundance of *Ambocoelia umbonata*, is overlain by the Bayview Bed, a unit yielding a diverse fauna, including patchy concentrations of the large rugose coral *Heliophyllum* and *Cystiphyllodes*, the brachiopods *Spinotrypa*, "*Mucrospirifer*" *consobrinus*, *Mediospirifer*, and abundant bryozoans. This bed is interpreted as a relative regression compared to adjacent Windom strata (Baird and Brett, 1983). The Bayview Bed is 36 cm above the Tichenor and offers the best opportunity for collection of macrofossils. Above the Bayview Bed is the Smoke Creek Bed, a 20 cm thick calcareous mudstone (Brett and Baird, 1994). The Smoke Creek Bed is characterized by an abundance of the small solitary rugose corals *Stereolasma* and *Amplexiphyllum*, the brachiopods *Pseudoatrypa* and "*Mucrospirifer*" *consobrinus*, and abundant *Phacops*, both whole individuals and molt assemblages. This bed lacks large corals and *Spinatrypa*, both common in the underlying Bayview Bed, and is believed to mark a transgressive transition into the fossil-poor mid-Windom facies (Brett and Baird, 1994).

Above the Smoke Creek Bed is a 2.5 m interval of unfossiliferous gray mudstone that correlates eastward to a sparsely fossiliferous interval designated the "Bear Swamp Interval" (Brett and Baird, 1994). Above the Bear Swamp equivalent is a concretionary limestone unit containing *Emanuella praeumbonata*. This layer correlates to the base of the mid-Windom dark-gray transgressive shale interval designated the Fisher Gully beds (Brett and Baird, 1994). The uppermost Windom at Eighteenmile Creek yields sparse *E. praeumbonata* and small concretions that correspond to the main part of the Fisher Gully beds in the Finger Lakes region (Figure 3b). The Windom succession on Eighteenmile Creek is condensed and truncated. Only the upper part of the *Ambocoelia* beds are present, and all of the upper-Windom succession (Tauton beds, Spezzano Gully beds, Gorge Gully beds, and newly discovered higher Windom strata in east central New York) is beveled (Figure 3c).

The North Evans Limestone ("Conodont Bed" of Hinde, 1879; Grabau, 1899), the basal stratum of the Genesee Group at Eighteenmile Creek, disconformably overlies the Windom Shale and represents a condensed and reworked bed at the great Taghanic Unconformity, a compound unconformity of several disconformities within the upper Hamilton and lower Genesee groups. To the east this erosive on lap is marked by the Leicester Pyrite, but here this major disconformity cuts out the upper Windom Shale, the Tully Limestone and its equivalents, most of the Genesee and Penn Yan shales, and the lower Genundewa Limestone. The North Evans Limestone is lenticular, up to 15 cm thick, medium dark gray pyritic, glauconitic biograinstone. The limestone is rich in crinoid ossicles, fish plates, shark teeth, brachiopods, styliolinids, and abundant conodonts, including *Polygnathus linguiformis*, *P. dengleri*, *P. dubius*, *P. pennatus*, *Klapperina cristatus*, *K. disparalvea*, *Icriodus latericrescens*, *Ancyrodella rotundaloba*, and *A. recta*, a mix of upper Givetian and lower Frasnian taxa. The North Evans Limestone likely represents multiple reworking events; locally thin black shale partings, lithologically similar to the Genesee and Penn Yan shales, are present.

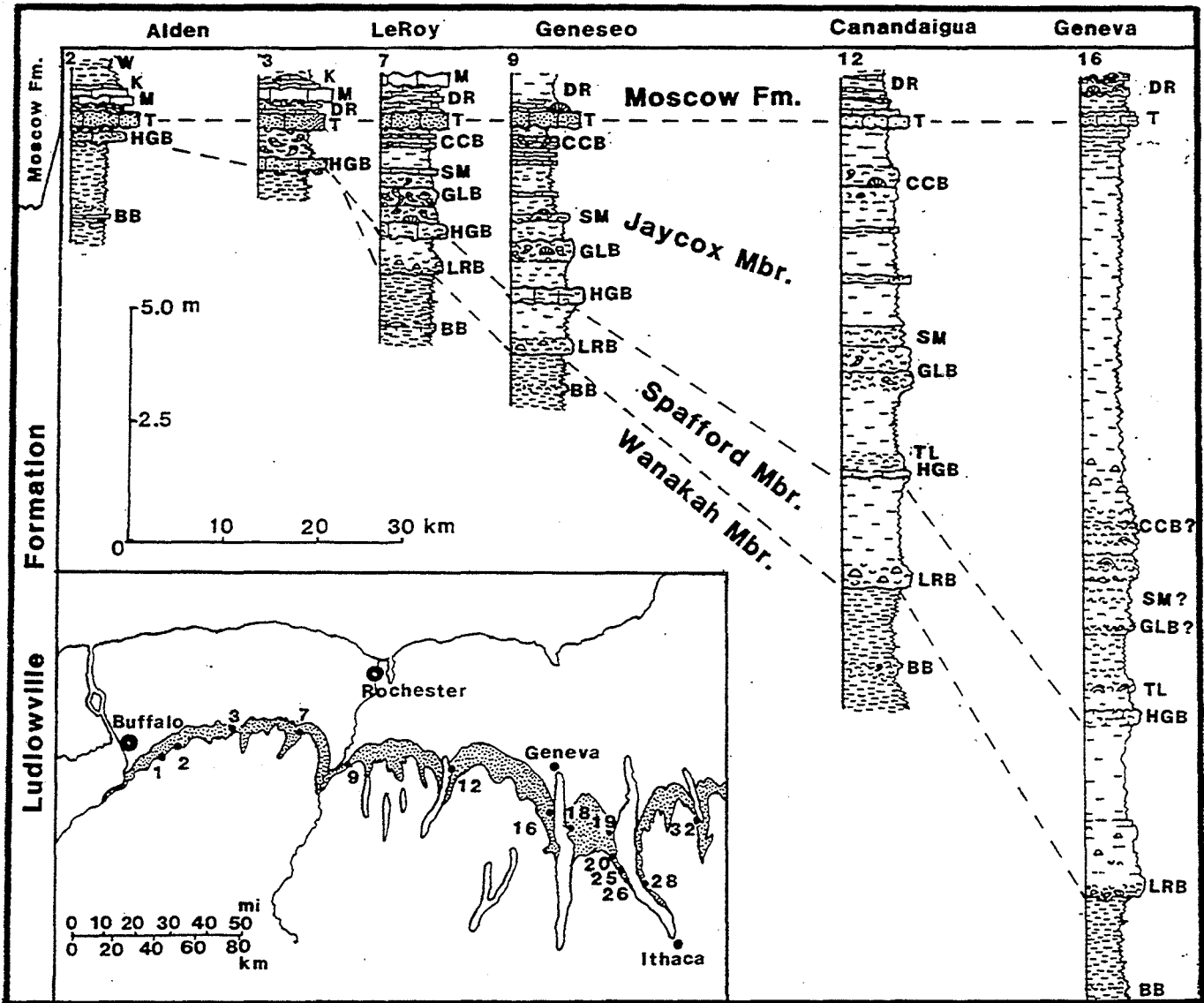


Figure 3a. Correlation of Tichenor, sub-Tichenor, and facies divisions of the upper Ludlowville and lower Moscow formations across western New York. Note prominent westward condensation, erosional truncation, and correlation of units that include: BB = Bloomer Creek Bed; CCB = Cottage City Coral Beds; DR = Deep Run Shale Member; GLB = Green's Landing Coral Bed; HGB = Hill's Gulch Bed; K = Kashong Member; LRB = Limerick Road Bed; M = Menteth Member; SM = Demosponge-Megastrophia Bed; T = Tichenor Limestone; TL = *Tropidoleptus-Longispina* mudstone interval; and W = Windom Member. From Mayer (1994).

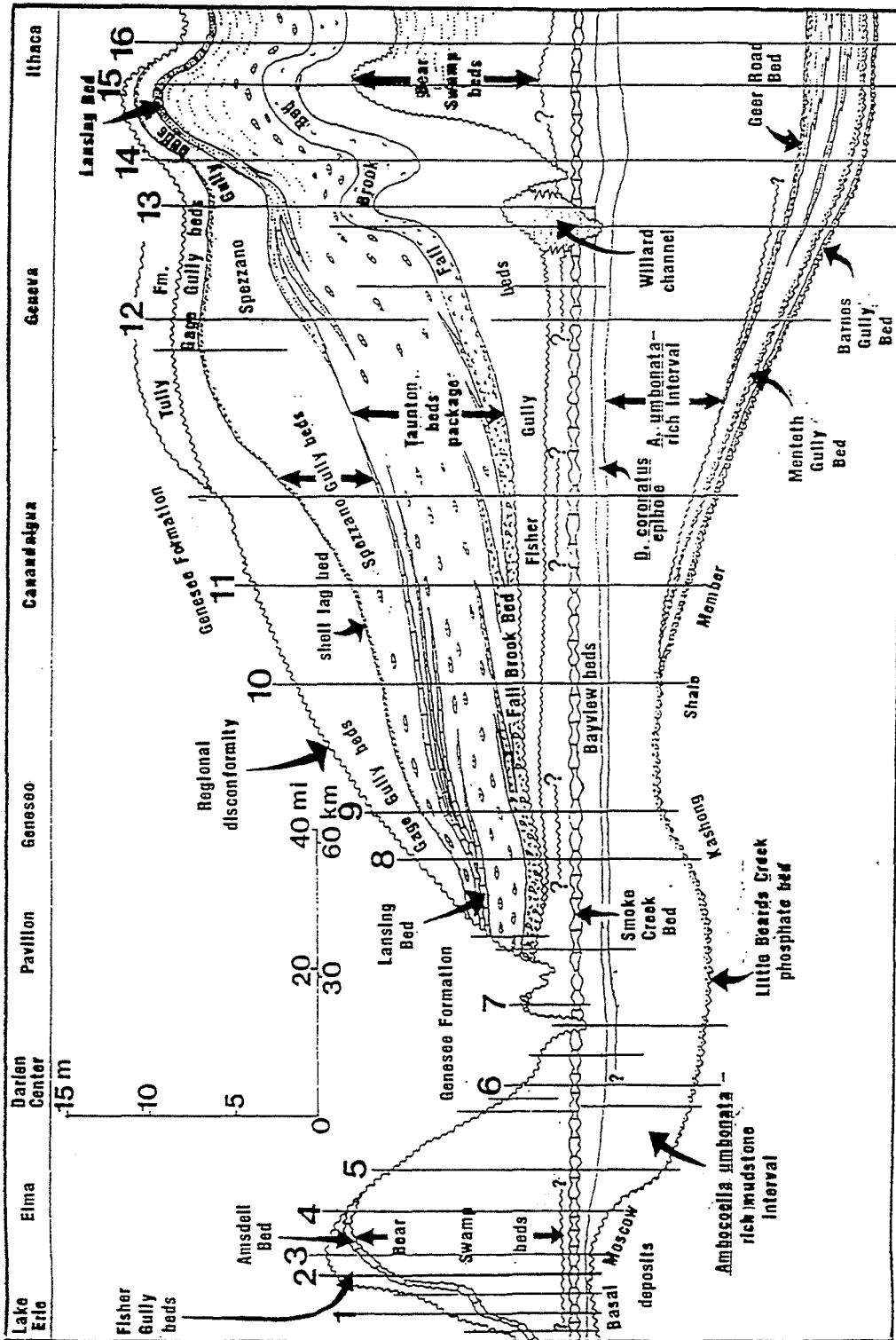


Figure 3b. Regional stratigraphy of the Windom Shale Member across western New York State. Datum is Smoke Creek Bed. Numbered localities include: 1, Eighteenmile Creek; 2, Penn Dixie Quarry; 3, Smoke Creek; 4, Cazenovia Creek; 5, Buffalo Creek; 6, Eleven Mile Creek; 9, Fall Brook; 10, Frost Hollow north of Honeoye; 11, menteth Gully; 12, Kashong Glen; 13, Simpson Creek at Willard; 14, Bloomer Creek; 15, Paines Creek; 16, Minnegar Brook near Lansing. From Brett and Baird (1994).

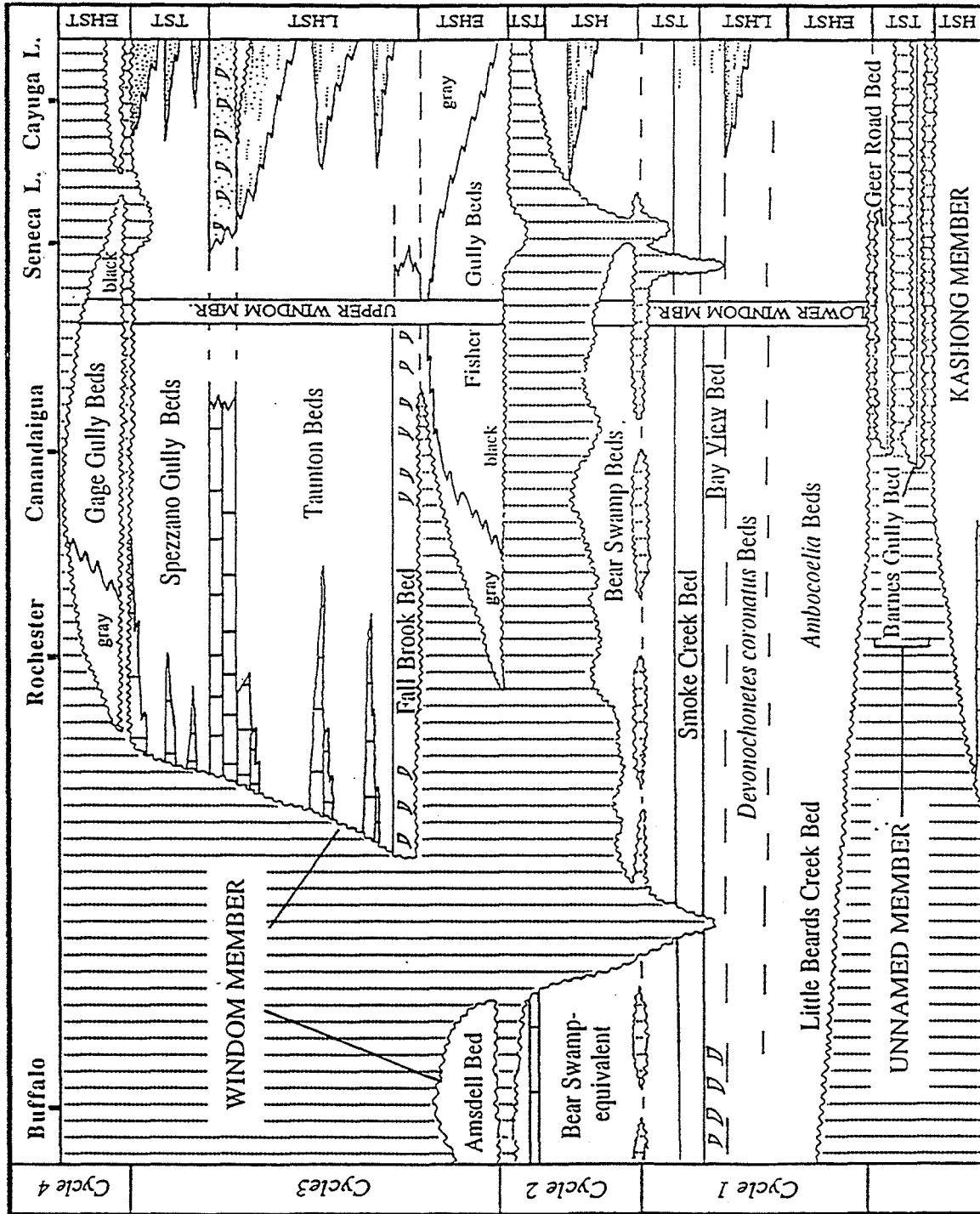


Figure 3c. Chronostratigraphic chart and sequence interpretation of the upper part of the Moscow Formation. Abbreviations for phases or system tracts (ST) include: TST = transgressive; EHST = early highstand; LHST = late highstand. Vertical ruling indicates unconformity; cornicopia = rugose corals; zig-zag lines indicate facies transitions. From Brett and Baird (1994).

A lenticular, up to 3 cm thick, dark gray styliolinid-rich shale overlies the North Evans Limestone. This shale is lithologically similar to the upper Penn Yan Shale, which to the east underlies the Genundewa Limestone and reaches a thickness of 11 m in the Genesee River Valley.

The Genundewa Limestone ("Styliolina Limestone" of Grabau, 1899) is a thin and wavy bedded medium gray bio-grainstone approximately 20 cm thick, and represents a starved basin "cephalopod kalkan" dominated by a pelagic fauna of styliolinids, conodonts, locally cephalopods, and terrestrial derived wood. This bed is believed to be the uniformly-bedded upper Genundewa Limestone of the Genesee River Valley and Canandaigua Lake region. The nodular lower Genundewa of eastern exposures, with the ammonoids *Koenites* and *Tornoceras*, is missing here. Conodont dating of the Genundewa is complicated by occurrences of reworked and transported elements of the North Evans fauna at the disconformity between the lower and upper Genundewa. The fauna of the lower Genundewa includes the late form of *Ancyrodella rotundiloba* and *Ancyrodella recta*, indicating lower Frasnian MN Zone 2. The fauna of the upper Genundewa, also with *A. recta*, marks the entry of the early form of *Ancyrodella rugosa* indicating MN Zone 3 (Kralick, 1994). In the Genesee River Valley the upper Genundewa marks the entry of the key Frasnian ammonoid genus *Manticoceras*.

The West River Shale on Eighteenmile Creek is 2.5 m thick, consisting of dark gray shale interbedded with thin siltstone beds and a concretion zone. *Styliolina* and the pelecypod *Pterochaenia* are both common. To the east, in the Genesee Valley and Canandaigua Lake region, thin limestones in the lower West River mark the entry of *Ancyrodella alata* (MN Zone 3). Concretions in the middle West River contain *Palmatolepis transitans* and mark the start of MN Zone 4 (*transitans* Zone). Here at Eighteenmile Creek the Williamsburgh Bed, a thin lenticular styliolinid-rich grainstone rich in wood, pyrite, and conodonts is tentatively recognized 0.5 m above the top of the Genundewa. This bed represents a sea level rise and recurrence of sediment starvation similar to the Genundewa Limestone. The conodont fauna of the Williamsburgh Bed includes *A. alata*, *A. rugosa*, *Icriodus nodosa*, *Mesotaxis asymmetricus*, *M. ovalis*, and *P. transitans*. The upper 2 m of the West River Shale at Eighteenmile Creek is correlated to the upper three meters of the West River in the Genesee River Valley where the entire formation is over 10 m thick. Individual beds of dark shale, siltstones, and concretions are recognizable. The lower West River is highly condensed or missing entirely in the westernmost exposures.

The Middlesex Shale, a black finely laminated pyritic and petroliferous shale, is 1.8 m thick at Eighteenmile Creek, and marks the base of the Sonyea Group. Millimeter and centimeter scale rhythmic laminations indicate small scale cycles (see Algeo and Woods, 1994), but their cause is problematic. Concentrations of wood and conodonts indicate intervals of even greater sediment reduction. The occurrence of *Ancyrodella gigas* (transitional to *A. nodosa*) and possibly *Palmatolepis punctata* indicate a position at or near the boundary between MN Zone 4 and MN 5 (*punctata* Zone).

The Cashaqua Shale, 12.8 m thick at Eighteenmile Creek, consists of light to dark green-gray shales and numerous concretion intervals. Concretion horizons, relatively evenly spaced through the Cashaqua, represent lower sedimentation rates and relatively greater carbonate accumulation and mobility after deposition, but before final compaction. The ammonoid cephalopods *Manticoceras sinuosum* and *Probeloceras lutheri* occur in the shales and concretions at several levels associated with the conodonts *Ancyrodella gigas*, *A. nodosa*, *Mesotaxis asymmetricus*, and

Palmatolepis punctata, indicating MN Zone 5. The prominent concretion horizon in the dark shale band near the top of the Cashaqua is the Shurtleff Septarian Horizon; it lies just below the base of the black Rhinestreet Shale. To the east this bed contains baritized ammonoids, including *Manticoceras sinuosum* and *Prochorites alveolatus*, as well as the conodonts *Palmatolepis punctata*, *Ancyrodella nodosa*, and *Ancyrognathus ancyrognathoides*, indicating MN Zone 6.

- | | | |
|------|-----|--|
| 14.6 | 0.0 | Continue north on South Creek Road. Continue north on North Creek Road. |
| 15.5 | 0.9 | At junction with NY 5, turn right (northeast) onto NY 5 East toward Buffalo, cross Eighteenmile Creek. |
| 16.0 | 0.5 | At intersection with North Creek Road turn right (southeast) onto North Creek Road. |
| 17.5 | 1.5 | At junction with US 20, turn left (northeast) onto US 20 East. |
| 24.9 | | Town of Hamburg water tower and US 62 (proceed on US 20) |
| 25.8 | 8.3 | At five corners turn right (east) onto US20A toward Orchard Park and East Aurora. |
| 35.7 | 9.9 | NY 78 meets US 20A at traffic circle in East Aurora, continue east on NY 78/US20A. |
| 39.8 | 4.1 | Turn right (south) on NY 78 South toward Strykersville. |
| 47.2 | | Strykersville US Post Office. |
| 49.6 | 9.8 | Cross Beaver Meadow Creek when entering Java Village and park on west side of road near post office. Creek and falls are east of NY78. Please respect the land owners along the creek. |

Stop 2 – Angel Falls on Beaver Meadow Creek at Java Village, Wyoming Co., NY. Upper portion of Nunda Sandstone, basal Pipe Creek Shale, “Nunda” Sandstone and the medial and upper Pipe Creek Shale.

Two thick bedded sandstone units are visible in Angel Falls on Beaver Meadow Creek in Java Village (Figure 4). This is the uppermost part of the greater Nunda Sandstone succession characterized by light gray thin to thick bedded cross-laminated and bioturbated coarse silt – very-fine quartz sand. The gray sandstones and silty mudstones at the base of the falls are separated from the upper sandstone that forms the top of the falls by a thin (10 cm-thick) black shale that marks the base of the Pipe Creek Shale Member. The lower and medial part of the Nunda Member interfingers and grades westward into the Angola Shale. The upper sand is stratigraphically distinct, designated “Nunda,” as it interfingers and toes out westward within the Pipe Creek Shale (Baird and Jacoby, 1999, herein, Fig. 1). The base of the “Nunda” sharply overlies the thin basal black shale bed; the top is interbedded and mixed with black shale.

The brownish lumpy sandstone of the topmost “Nunda” and superadjacent Pipe Creek Shale show chaotic bedding, irregular sandstone masses, and complex swirly interlayering of micaceous sandstone and sandy black shale. Diffuse breccia clasts of black shale within brown sandstone matrix suggests emplacement of fluidized sand into variable water-rich, surficial black mud deposits. The thick “Nunda” sandstone seems to be a major fan lobe sand unit (Jacobi et al., 1994; Baird and Jacoby, herein). The “Nunda” flow event scoured the lowest Pipe Creek Shale as indicated by olistoliths of Pipe Creek Shale within the massive unit at several localities. The uppermost chaotic and diffuse “Nunda” Sandstone may represent later, smaller flow events.

Nunda Sandstone/Pipe Creek Shale
 Beaver Meadow Creek
 Java Village - Angel Falls
 measured 6 August 1999

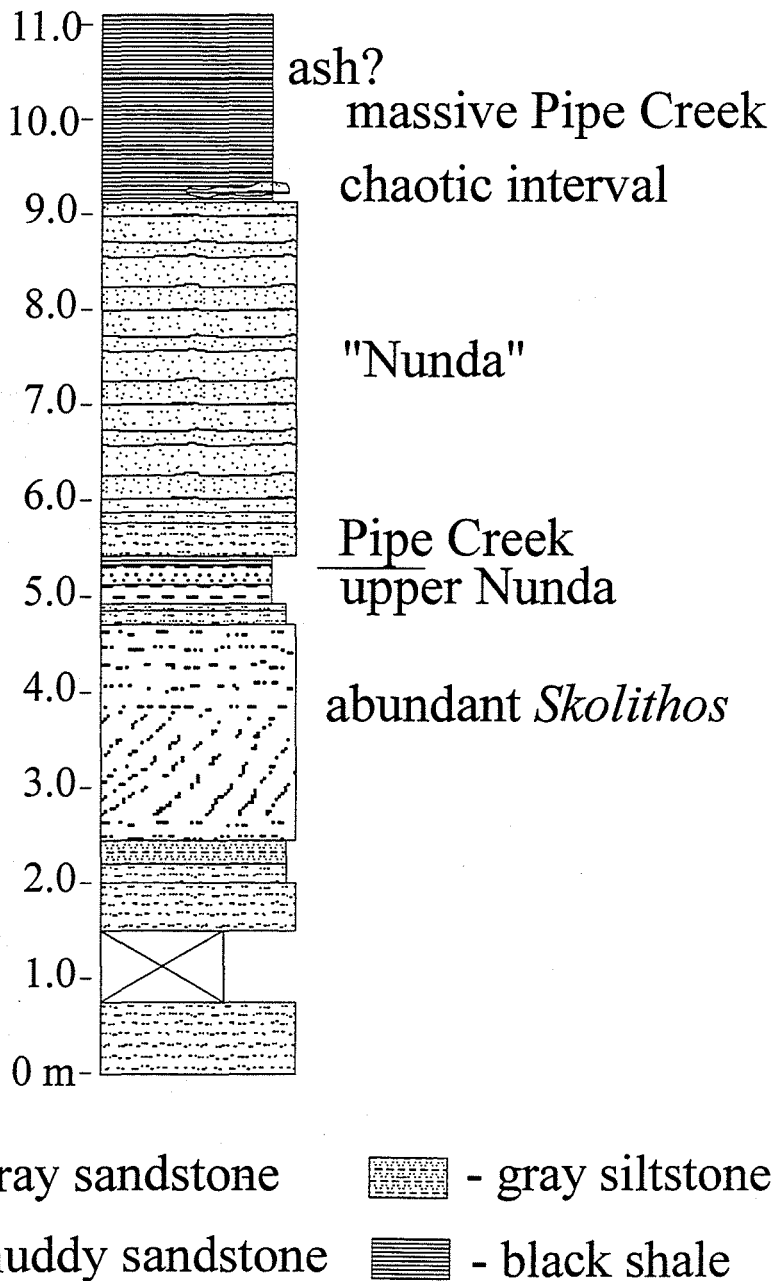


Figure 4. Schematic diagram of upper Nunda Sandstone, "Nunda" Sandstone, and lower Pipe Creek Shale at Angel Falls on Beaver Meadow Creek in Java Village. between MN Zone 12 and Zone 13. In the lower Hanover Shale, just above the top of the Pipe Creek Shale, there are nodular beds which yield baritic specimens of *Mantiococeras cataphractum* associated with conodonts of MN Zone 13.

The Pipe Creek Shale is the northern Appalachian Basin equivalent to the Lower Kellwasser Horizon in Europe (Over et al., 1997; Over, 1997). Conodonts in the Pipe Creek Shale include *Palmatolepis winchelli*, *P. aff. P. hassi*, and *Polygnathus samueli*, indicative of the boundary

- 49.6 0.0 Turn around and head north on NY 78 to Strykersville.
- 52.0 2.4 Turn right (east) on Perry Road (just past post office).
- 53.6 1.6 Turn left (north) on Bartz Road.
- 54.3 0.7 Pull off on road side on south side of Glade Creek. This is private property and visiting the site is contingent on permission from the land owner. Walk west down the farm lane, right at implement shed and down to the creek.

Stop 3 – Glade Creek, Wyoming Co., NY. Hanover Shale, Frasnian-Famennian boundary mass extinction, and Dunkirk Shale.

The Hanover Shale in the Buffalo Creek Valley is predominantly green-gray pyritic silty shale. Dark organic-rich shale, muddy limestones, siltstones, and calcareous concretions are common (Figure 5). Three distinctive black shale intervals and numerous thinner black shales correspond to deepening phases or circulation changes and preservation of organic material in the substrate. The upper Hanover Shale is characterized by numerous black shale interbeds, indicative of deepening and a reduction in coarser clastic influx, as well as reduced oxygen levels in the substrate. The black shales amalgamate or are truncated westward (Baird and Lash, 1990), as a result of sediment reduction and/or submarine erosion. Black shales and calcareous concretions contain carbonized plant material, gastropods, crinoid debris, pteriacid bivalves, cephalopod aptyci, and an abundant and diverse conodont fauna. The upper Hanover at this locality is the source of the large goniatite *Sphaeromanticoceras rickardi* the last known mantioceratid of the New York Frasnian (House and Kirchgasser, 1993). A radical change in the conodont fauna marks the Frasnian-Famennian.

The Frasnian-Famennian boundary is one of the major biotic events in the Phanerozoic, recognized by the extinction of shallow water corals, most stromatoporoids, and numerous species and higher groups of trilobites, cephalopods, brachiopods, and conodonts. The mass extinction is associated with sea-level fluctuations and deposition of organic-rich fine-grained sediments in tropical seas. In Europe the Kellwasser horizons, two distinct organic-rich intervals, mark the onset and culmination of the extinction. It is estimated that 22 percent of extant families and 65 percent of extant genera went extinct (Hallam and Wignall, 1997). There is no compelling evidence for the single impact of a large bolide as the cause of the extinction (Walliser, 1995; Over et al., 1997).

The thick black shale corresponding to the Upper Kellwasser horizon is characterized by a diverse and abundant nektic and planktic fauna. Locally there are numerous homoctinids, pteriacid bivalves, *Sidetes* (cephalopod aptycus), current aligned orthocone nautiloids and conodonts, articulated fish, and carbonized plant remains. The conodont fauna is characterized by *Palmatolepis bogartensis*, *P. winchelli*, *Ancyrodella* sp., *Ancyrognathus* sp., *Icriodus alternatus* ssp., and *Polygnathus* sp. The concentration of fossil remains in the top of the bed indicates relatively slow sedimentation, that in association with the finely laminated pyrite-rich shale, suggests a relative sea level rise and submarine erosion. Numerous graded and current oriented silt laminae indicate turbidity flows or other bottom currents during black shale

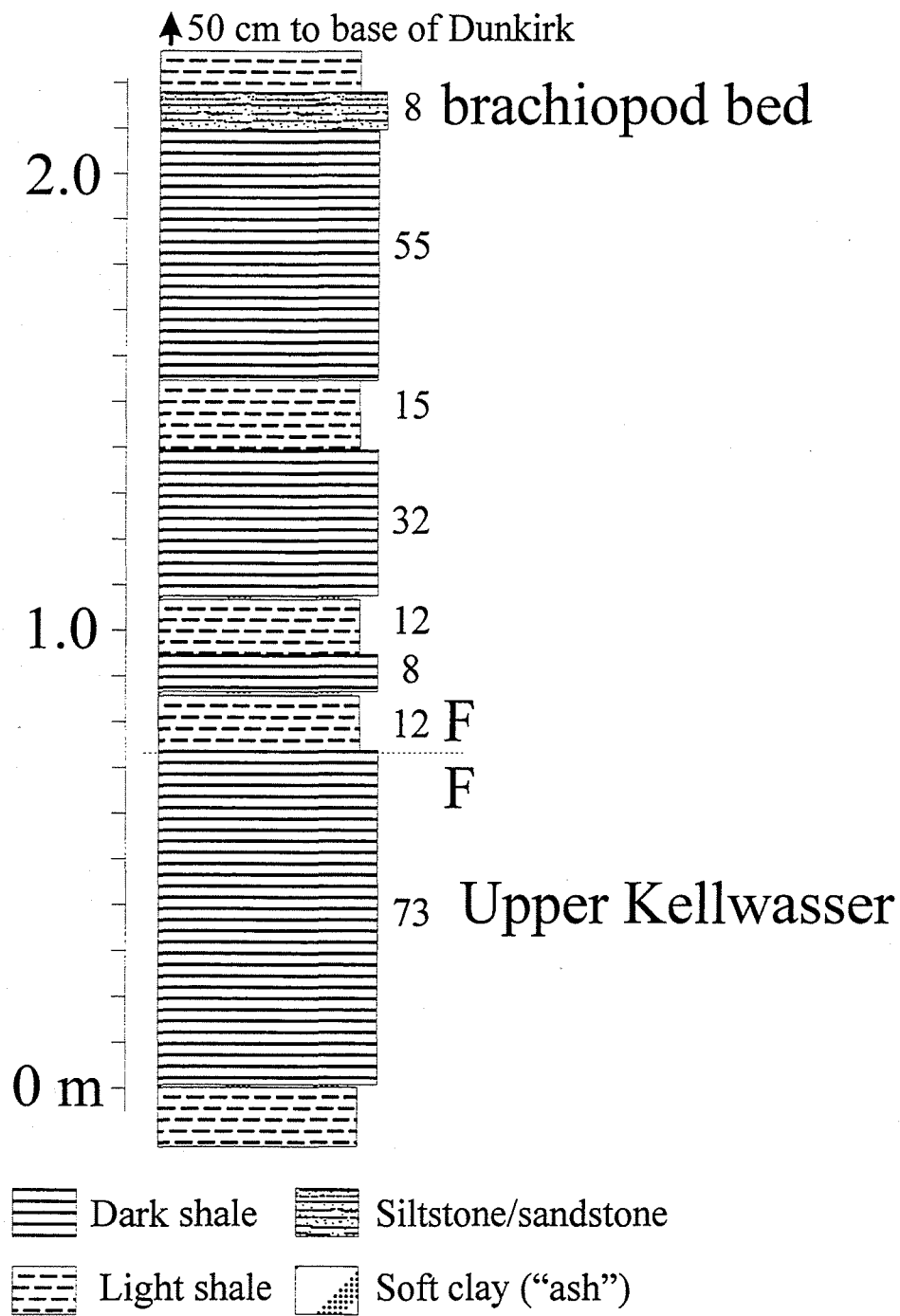


Figure 5. Schematic lithologic section of Frasnian-Famennian boundary interval in the upper Hanover Shale at Glade Creek, Bartz Road, Wyoming County, New York.

deposition. Hummocky cross laminated siltstones in the boundary interval indicate that these strata were deposited near storm wave base.

Fossil abundance drops precipitously above the Upper Kellwasser black shale, corresponding to the Frasnian extinction horizon. Recovery of conodont and benthic fauna is evident in the overlying meter of the Hanover. A ripple laminated 5-8 cm thick, medium gray coarse siltstone, that consists of three fining upward intervals, 1.2 m above the extinction boundary, contains a diverse offshore shelf brachiopod fauna that represents a concentrate from the underlying greenish mudstones. The fauna consists of *Schizophoria* sp., *Thiemella* cf. *T. leonensis* (Hall), *Whidbornella* cf. *W. lachrymosa* (Hall), "*Chonetes*" cf. "*C.*" *setigera* (Hall), *Evanoscirostrum?* sp., *Athyris angelica* (Hall), *Tylothyris* aff. *T. mesacostalis* (Hall), *Cyrtospirifer* cf. *C. inermis* (Hall), and *Linguloides?* sp. These are taxa that carry over from the Frasnian, and suggest a relatively high survival rate for deep shelf brachiopods. This bed also contains numerous specimens of *Palmatolepis triangularis*, fish remains, and bivalves. Brachiopods are present in the under- and overlying strata, but are only concentrated in a single interval in the middle of the bed, developed in a coarser and more pyritic zone over clay-rich and bioturbated laminae. The pyrite and shell interval overlies a low relief scour surface, indicating a concentration of coarser and denser material during higher energy conditions. The shell-bearing bed is characterized by low amplitude ripple marks that have a 6-7 cm frequency where the ripple crests are oriented NNE-SSW. Brachiopods, and in a lesser abundance crinoids, ostracodes, bryozoa, fish remains, and conodonts, cover the entire surface of the shell horizon. Many brachiopod valves are disarticulated and convex up, but otherwise there is little shell abrasion or other evidence of transport. Some of the larger brachiopod shells are at the top of the bed and concave up, possibly the result of suspension and settling. Abundant lingulid valves (n = 184) have a preferred, but not pervasive, long axes alignment in a NW-SE orientation, perpendicular to the current ripple crests.

The Dunkirk Shale, the lowest formation in the Canadaway Group, overlies the Hanover Shale. The Dunkirk is defined by the first occurrence of massive black shale above the green-gray shales and thin black shale interbeds of the Hanover, and is equivalent, at least in part, to the lower part of the Huron Shale in Ohio. The type section of the Dunkirk Shale is at Pt. Gratiot, Town of Dunkirk, on the Lake Erie shoreline. The basal Dunkirk yielded *Palmatolepis triangularis*, *P. subperlobata*, *P. delicatula delicatula* and *P. clarki*, characteristic of the Middle *triangularis* Zone. These species range into succeeding zones, but with the exception of juvenile specimens suggestive of *Palmatolepis perlobata* ssp. or *P. tenuipunctata*, conodonts indicative of the Upper *triangularis* Zone or younger were not recovered. *Palmatolepis glabra*, *P. perlobata*, *P. quadrantinodosalobata*, *P. subperlobata*, and *Ancyrognathus bifurcatus* were reported by Hass (1958) from the South Wales and Gowanda formations, which overlie the Dunkirk. This fauna is characteristic of a position no lower than the *crepida* Zone.

- 54.3 0.0 Continue north on Bartz Road through crossroad of Sheldon where St. Cecelia (large church at cross road) is the dominant feature. Continue north to US 20A.
58.2 3.9 Turn left (west) on to US 20A toward East Aurora, I-90, and Fredonia.

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