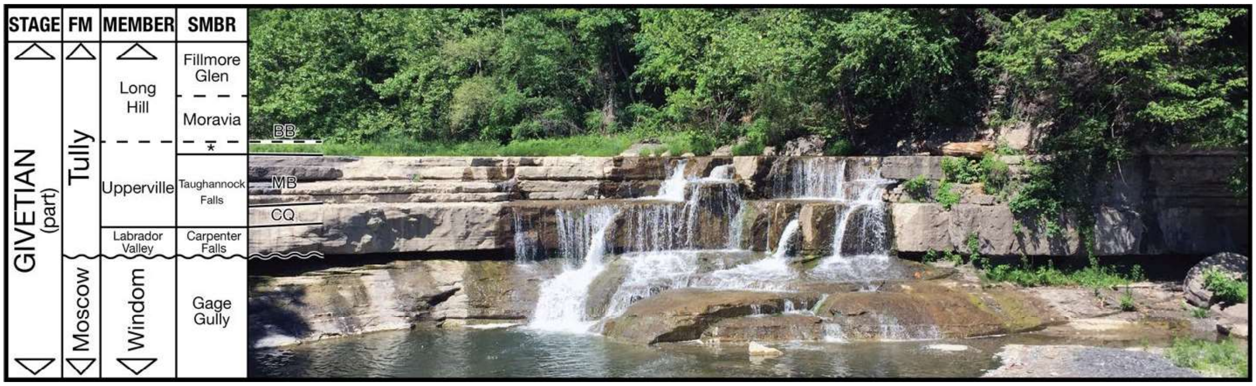


Lower and Middle Devonian Strata of New York State:

Genesee River Valley to the Hudson Valley
August 3-7, 2023

SDS 2023 Post-Meeting Field Trip

Trip Leaders:
Alex Bartholomew and Charles Ver Straeten

<u>Field Trip Guidebook Authors/Editors:</u>
Alex Bartholomew and Chuck Ver Straeten

<u>Field Stop/Introduction Authors/Presenters:</u>
Gordon Baird
Alex Bartholomew
Carlton Brett
Anne-Christine Da Silva
James Ebert
William Kirchgasser (deceased)
D. Jeffrey Over
William Stein
Dennis Terry
Chuck Ver Straeten
James Zambito

Authors Note:
The authors view this edition of this guidebook as a draft, likely with abundant errors in both formatting and content. We apologize for the state of this guidebook upon printing and welcome any suggestions and corrections from trip attendees. We will distribute a revised version to all trip attendees at a later date. AJB & CVS

Cover Photos:
Top: Lower Taughannock Falls, credit: James Zambitto
Bottom Left: Aerial vew of Catskill Escarpment looking west. Credit: Joe Gianelli
Bottom Right: Vromans Nose, Schoharie Valley. Credit:
http://alloveralbany.com/archive/2014/10/02/quick-trip-vromans-nose

QR Codes for links to Google Map locations for each stop on Post-Meeting Fieldtrip.

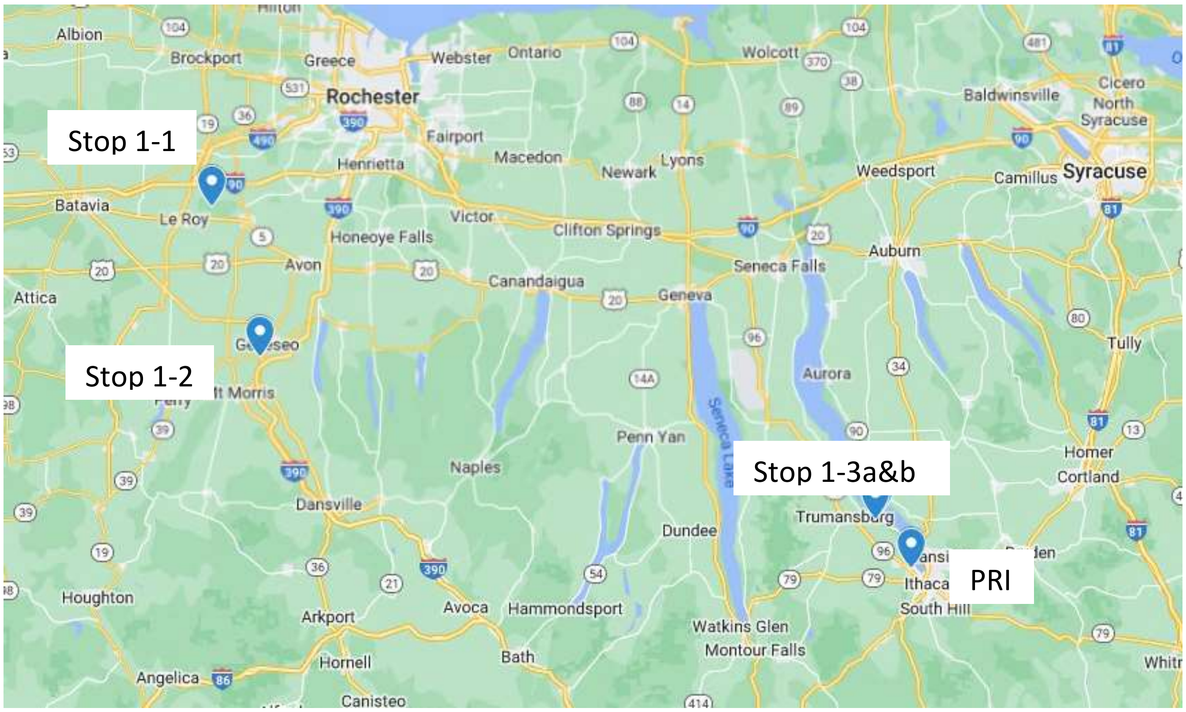
For each stop, using the camera on your smart-phone, center the QR code for any location in the frame of the camera screen and a link will pop-up. Tap on this link and it will take you to the Google Map website location for the stop.

Stop 1-1: Neid Road Quarry	Stop 2-1: Hubbard Quarry	Stop 3-1: Tully Quarry	Stop 4-1a: Thacher Park Visitors' Center	Stop 5-1: Rte. 199 Helderberg Gp.
Optional Stop: Honeoye Falls Quarry	Stop 2-2: Grove's Creek	Stop 3-2: Nedrow Rte 11	Stop 4-1b: Carrick Rd. Quarry	Stop 5-2: Rte. 199 Tristates Gp.
Stop 1-2: Fall Brook-Dewey Hill	Stop 2-3: Fayette Quarry	Stop 3-3: Pompey Cut	Stop 4-1c: Thompsons Lake Reef	Stop 5-3: Rte. 209 East Berne-Halihan Hill Bed
Stop 1-3a: Lower Taughannock Falls	Stop 2-4: Cascade Cuts	Optional Stop: Swamp Rd.	Stop 4-2: Shell Inn	Stop 5-4: Rte. 209 Stony Hollow-Cherry Valley
Stop 1-3b: Taughannock Falls	Stop 2-5: Long Hill Rd.	Stop 3-4: Rte. 20 Cherry Valley	Stop 4-3: Gilboa Museum	Stop 5-5: City View Terrace
Stop 1-4: PRI	Stop 2-6: Portland Point	Stop 3-5: Chestnut Street	Stop 4-4: East Windham Cuts	Stop 5-6: Rte. 28 Ashokan Fm.

Ithaca Quality Inn	Tully Quality Inn	Stop 3-6: I-88 cuts	Stop 4-5: Cairo Town Quarry	Stop 5-7: Plattekill Fm.
		Howes Caverns Motel	Stop 4-6: Rte. 23 Cuts	Stop 5-8: Rte. 23 Schoharie-Onondaga fms.
			Stop 4-7: Rte. 23A Abandoned Thruway Exit	Optional Stop: Platte Clove Corner outcrop
			Saugeties Comfort Inn	Stop 5-9: North-South Lake
				Saugerties Comfort Inn

Field Trip Day 1 – 8/2/2023

Stop 1-1	Neid Road Quarry
Optional Stop	Honeoye Falls Quarry
Stop 1-2	Fall Brook/Dewey Hill
Stop 1-3	Lower and Upper Taughannock Falls
Stop 1-4	Museum of the Earth at the Paleontological Research Institution



Depart SUNY Geneseo:

0.0 mi	Depart SUNY Geneseo. Head east on Bank St toward Main St
300 ft	Turn left onto Main St
0.26 mi	Turn left onto Court St
0.65 mi	At the traffic circle, take the 1st exit onto NY-63
3.88 mi	Turn right onto Retsof Rd
1.61 mi	Turn right onto NY-36 N
5.63 mi	Turn left onto Black Street Rd
1.92 mi	Turn right onto McEwen Rd
0.78 mi	Continue onto York Rd
2.33 mi	Turn left onto NY-5 W
0.22 mi	Turn right onto Church Rd
0.92 mi	Turn left onto Gulf Rd
0.25 mi	Turn right onto Neid Rd
0.33 mi	Turn left to stay on Neid Rd

STOP 1-1. ABANDONED NEID ROAD QUARRY, EAST OF LEROY

Stop Authors: Brett, Baird, Ver Straeten

Stop Leaders: Brett, Baird, Ver Straeten

Locality: Abandoned limestone quarry north of Gulf Road and accessible from old ramp road in northeastern corner at the dead-end of western branch of Neid Road with turn at ~0.3 miles north of junction with Gulf Road; LeRoy, Genesee County, NY; parking by permission of homeowner 42.996953, -77.929549; proceed through gate, on foot straight west on old road to ramp. North quarry wall with irregular unconformity is northwest of ramp at 42.998999, -77.933752

Reference: Brett et al. (2000) described the sub-Oriskany-Bois Blanc (Wallbridge) and sub-Onondaga unconformities in detail with a focus on this quarry and the detailed anatomy of the disconformable surfaces. For detailed discussion see that article.

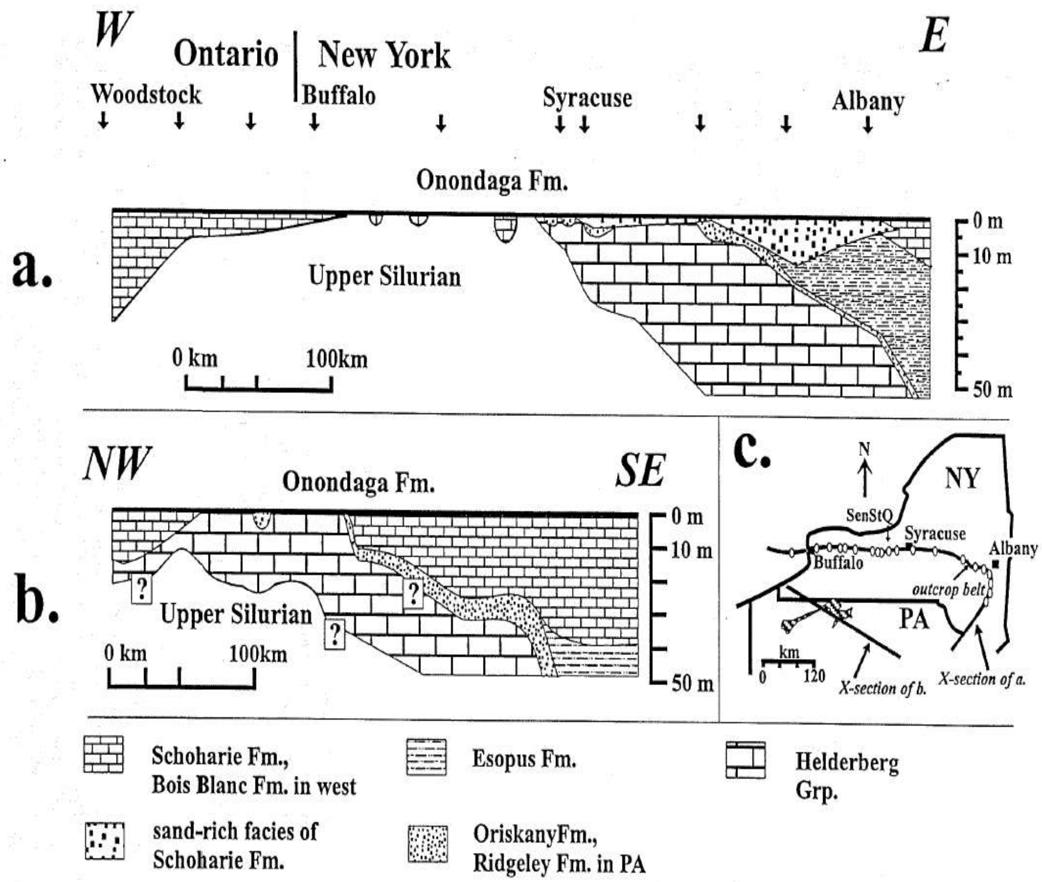
Description of units: This large abandoned quarry exposes Upper Silurian (Pridolian) strata of the Bertie Group and Cobleskill-Akron member of the Rondout Formation, and Lower Devonian (Emsian) strata of the Bois Blanc Formation and lower Edgecliff Member of the Onondaga Formation. Adjoining quarries along Gulf Road expose additional strata of the upper Edgecliff, Nedrow, and Moorehouse members of the (lower to middle Eifelian) Onondaga Limestone. At this stop we will focus our attention to the northeast corner of the quarry, examining relationships between the top Silurian, Bois Blanc, and basal Onondaga units. At this quarry two major unconformities show dramatic features as both Bois Blanc and Edgecliff Member of Onondaga show local onlap onto an irregular erosion surface on upper Silurian Bertie and Akron formations (Text-fig. 1-1.1).

One of the most significant features of the Neid Road quarry is the locally complex topography of Upper Silurian strata, which in one area features prominent knobby pinnacles and undercut cavities through the fine-grained dolostones. The overlying Devonian units are variously draped over the highs and settled into the cavities below. In addition, the thin Bois Blanc interval undergoes dramatic lithologic changes between a relatively low, level background topography and the adjacent highs. The changes range from relatively fine-grained, brachiopod wackestones in "background" areas to packstones and coarse, rubbly, coral- and crinoid-rich rudstones and grainstones adjacent to local high knobs.

The quarry is floored by thinly bedded, fine grained dolostones of the Upper Silurian (Přídolí) Fiddlers Green Formation of the Bertie Group. Characteristic large salt hopper casts are locally common in the formation; rarely, eurypterid remains have been found. The overlying Scajaquada Formation, darker gray, shaly, thin-bedded dolostone, is poorly exposed in the lower sides of the quarry walls and extends up into fine-grained waterlimes of the overlying Williamsville Formation. Across most of the quarry the much of the Williamsville Formation is erosionally truncated by a composite unconformity; generally, about 0.8 m of the unit remains below the erosional surface. The surface of the unconformity along most of the quarry wall is generally relatively planar, with local humps up to approximately a half meter high and a couple meters across. The uppermost dolostone layers show subtle features associated with unconformity development, including a weathered, spongy appearance in the upper few centimeters, and sand-filled *Trypanites* borings indicating an indurated rockground substrate at the time of colonization by the producers, possible sipunculid worms. Quartz sand-filled neptunian dikes are visible down to at least 0.7 m below the Silurian-Devonian contact, locally.

Along the quarry walls on the east and west, the unconformity is overlain by the thin (<1.5m) upper Emsian (upper Lower Devonian) Bois Blanc Formation. Two divisions are recognizable in the Bois Blanc along the east wall (Text-fig. 1-1.2): a lower, recessive-weathering interval of argillaceous sandstone with reworked clasts, phosphate, and glauconite, and lensing, nodular limestones informally termed the “Springvale” sandstone, and a more resistant ledge of fossiliferous, fine- to medium-grained limestones (unnamed member).

The "Springvale" at the Neid Road quarry consists primarily of approximately 30 cm of



Text-fig. 1-1.1

Cross section of Devonian strata below the sub-Onondaga unconformity along the New York outcrop belt (a) and in the subsurface of southwestern New York and northwestern to central Pennsylvania (b). Map (c) shows distribution of cross-sections. From Ver Straeten and Brett, 2000; data for cross-section b from Rickard (1989).

argillaceous siltstone to sandstone (Text-fig. 1-1.2); the unit locally thins over low mounds of the Silurian and thickens in topographic lows. **A** yellow clay occurs locally at the contact. Different layers internal to the "Springvale" may feature reworked clasts of dolostone or phosphate, or even chert replaced favositid corals. Glauconite is present in some beds, along with a few meristellids and other brachiopods. A transitional cap to the "Springvale" comprises alternating lenses of fossiliferous micritic limestones and thin shales.

The upper (unnamed) limestone member of the Bois Blanc along the eastern wall (Text-fig. 1-1.2) consists of a ledge, approximately 0.8 to one meter thick, of relatively tabular, gray wacke- to packstones. The lower interval, generally weathering as two beds (ca. 30 cm-thick

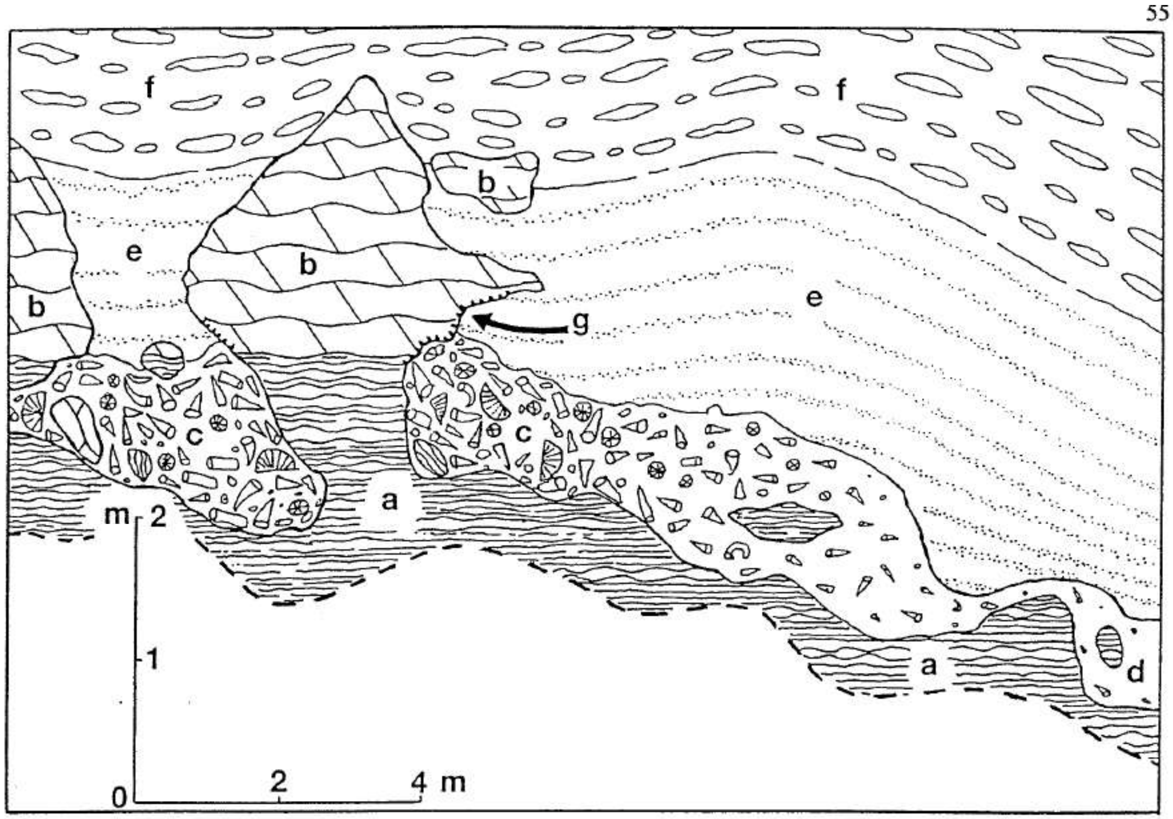
At this quarry these unconformities are dramatically exposed and both Bois Blanc and Edgecliff Member of Onondaga show local onlap onto an irregular erosion surface on upper Silurian Bertie and Akron formations. The Bois Blanc contains a fauna of predominantly small to medium-size brachiopods, with ambocoeliids and a meristellid, along with platyceratid gastropods, and some small rugose corals. The upper bed features scattered medium-sized rugosans *(Metaxyphrentis* [formerly *Heterophrentis*] *prolifica* and a cystiphyllid) and medium to large brachiopods. Faunally and lithologically, the Bois Blanc limestones appear to represent relatively offshore, shelf-like facies, with a general coarsening-up/shallowing-up trend into the upper bed.

The top of the Bois Blanc is marked by an irregular topography and a thin crevice, which features a yellowish clay (< 1 cm-thick), which may represent a bentonite bed. A similar clay has been seen at the Bois Blanc-Onondaga contact in Ontario, Canada.

The contact is overlain by approximately 0.9 m of relatively coarse, non-cherty grainstones of the Edgecliff Member. The contact is relatively horizontal along the eastern wall, although it can be seen to rise subtly above the crests of the low paleo-bedrock mounds of Silurian dolostone at the unconformity. The basal grainstone facies of the Edgecliff is succeeded by a thick succession of Clarence chert-rich facies. The Edgecliff Member totals 12.9 m and is fully exposed in the Neid Road and adjacent Gulf Road quarries.

These patterns are representative of the Silurian and Lower Devonian transition zone around much of the Neid Road Quarry. However, immediately adjacent to the ramp road, in the northeast comer of the quarry, the stratigraphy becomes much more complex.

On the northeast wall we observe remnant topographic highs on the Silurian bedrock; localized knobs, or pinnacles, that extend at least 3 meters up above the normal, background topography of the Silurian bedrock (cross- section, Text-fig. 1-1.2). In places the full 2.9 m of the Williamsville are preserved, with overlying Cobleskill/Akron Formation visible with its small, recrystallized corals. The paleotopographic highs, which may have been small "sea stacks" along the Bois Blanc to Edgecliff coastlines, are locally undercut by cavities. The pinnacles, and isolated chunks of the Williamsville and Cobleskill/Akron that are apparently attached to the main bedrock mass, stand surrounded by a matrix of Devonian strata. In a few places, a thin, continuous fill of Bois Blanc is observed in elongate narrow cavities that are open at both ends. These various features may be due to karstification, or possibly be related to widening of joints (grikes) and physical cutting/erosion during sea level advance over a rocky coastline. Kobluk et al. (1977) reported etchings into Silurian bedrock, at the same unconformity near Fort Erie, Ontario, that they interpreted to be associated with rhizomes of early land plants,



Text-fig. 1-1.2 Diagrammatic view of irregular erosional contact (Wallbridge Unconformity) of Silurian Bertie-Cobleskill dolostone and Devonian Bois Blanc and Onondaga limestones, at Neid Road Quarry, LeRoy, Livingston County, New York. Note irregular knob ("sea stack") of dolostone and onlapping relationship of the overlying Devonian skeletal carbonate sediments; also note Devonian skeletal debris filling in pockets below projecting ledges of Silurian dolostone. Lettered features include: a) Williamsville Dolostone (Upper Silurian, Pridoli, Bertie Group): rhythmically laminated, light gray dolostone("waterlime"); b) Cobleskill/Akron Formation (Upper Silurian); massive, mottled dolostone with rare corals; c) Bois Blanc Limestone (Lower Devonian, Emsian) note coarse, coral-rich packstone and grainstone, with some dolostone clasts near bedrock knob; note that this unit terminates against Silurian bedrock and grades laterally into d) finer grained packstone-wackestone typical of Bois Blanc in surrounding exposure; e, f) Edgecliff Member (Lower to lowest Middle Devonian; Emsian-Eifelian; Onondaga Limestone); e) lower submember; medium grained, well sorted pinkish gray crinoidal grainstone; note that this unit also terminates against bedrock knob; f) upper submember, "Clarence" facies, light gray, bioturbated lime mudstone with abundant dark, bluish gray chert nodules; note that this unit drapes the bedrock knob; g) *Trypanites* borings in ceiling of overhanging ledge.

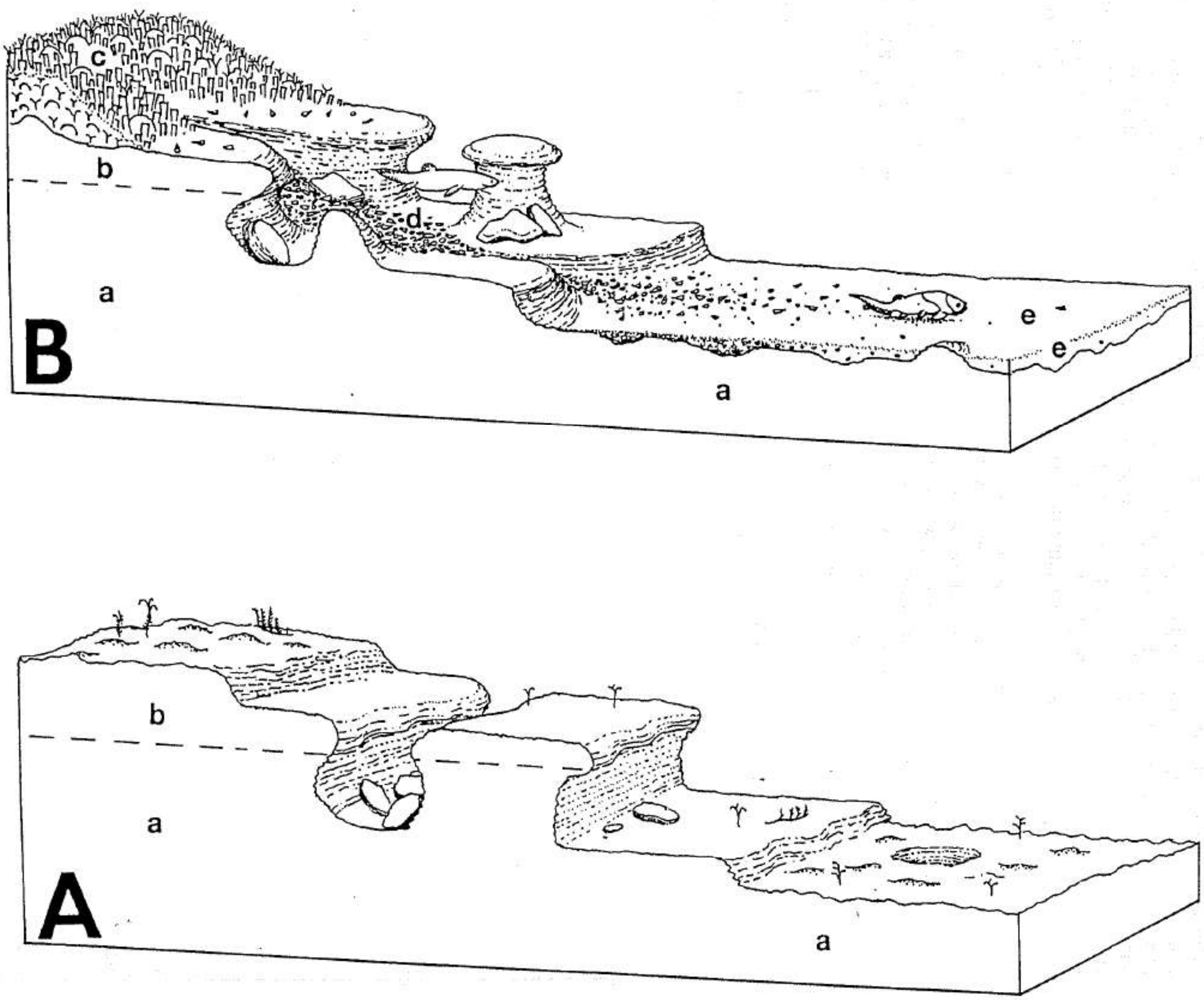
indicating subaerial exposure of the bedrock during lowstand events. They also reported indications of marine erosion processes, including bioerosive activity, associated with *Trypanites* rockground borings. We have not at present identified plant related etchings here. No borings were noted on the top surface of the Williamsville along the outcrop, away from the pinnacles. However, on some of the isolated pods that would have been standing above the sea floor and on the adjacent pinnacles, *Trypanites* borings are notable. In addition, to the west of the measured section, toward the far end of the "pinnacles" outcrop (away from the quarry ramp), a channel-like feature also occurs, infilled with Bois Blanc limestones (Text-fig. 1-1.3b).

Draped over this topography, across the lower parts of it, are coarse coral- and crinoid-rich rudstones with some grainstones (Text-fig. 1-1.3c-1-1.3d). This facies, which might generally be associated with the basal Edgecliff in New York, can be seen to grade laterally to the northwest and the southeast into the normal, generally brachiopod-rich wacke- to packstones, and even the basal muddy phosphatic sands and lenticular carbonates, of the Bois Blanc Formation. The coarse facies features a relatively diverse fauna, including a number of different solitary and colonial rugose corals, and *Pleurodictyum* and *Favosites*, along with abundant echinoderm debris, medium to large brachiopods, and conocardiid rostroconchs. In places there is a finer-grained unit at the top that locally even becomes shaly. A thin recessed interval of muddy, phosphatic sandstone to shales with glauconite also occurs locally at the bottom of the Bois Blanc on the northeast wall, and locally infills cavities, as seen at 17 m on the cross-section (cross-section Text-fig. 1-1.2). The coarser, coral- and crinoid-rich facies can also be seen to fill around knobs and cavities in the underlying Silurian strata (Text-fig. 1-1.3). The Bois Blanc ranges in thickness along the northeast wall from 0 to 72 cm and terminates against the highest Silurian pinnacles/knobs.

Where the knobs stand above the top of the Bois Blanc, they are typically draped by the chert-free, crinoidal basal Edgecliff strata. However, in a few places the knobs stand up over the basal Edgecliff unit and are draped by cherty strata of the overlying Clarence facies of the Edgecliff. A distant view of the outcrop shows that the various lower Edgecliff layers appear to rise locally over the pinnacles.

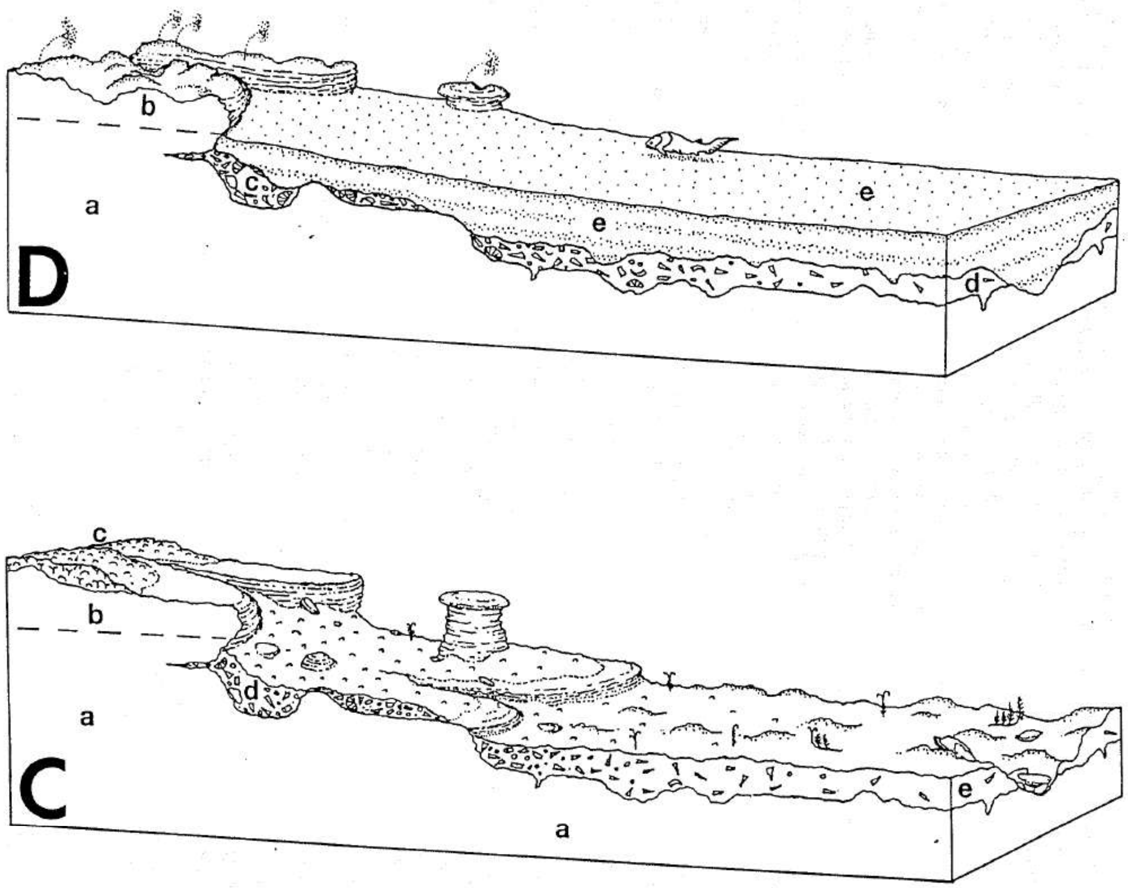
Development of the coral-rich facies over the topographic high appears to be varied. Across the ramp road, approximately 100 m to the southeast, two thin wedges of coral-crinoidal rudstones pinch out locally into the thin limestone interval at the top of the lower, recessive Springvale unit. The lower part of the upper limestone ledge appears coarser than the upper part locally also. In the opposite direction, across a covered distance of more than 100 m, there appear to be three intervals of coarser, coral-rich facies, separated by finer-grained calcarenite- calcisiltite facies. Thus, it appears that development of the coralline communities occurred repeatedly during deposition of the Bois Blanc Formation.

The abrupt changes in litho- and biofacies between the relatively deeper shelf, brachiopod-rich wacke- to packstones along the sidewalls of the quarry and the coarse rudstones of corals echinoderm debris in the "pinnacles" area imply a sharp ecological gradient locally during deposition of the Bois Blanc. A visible relief of approximately three meters in the quarry walls would not appear to account for enough depth change to support this gradient. It may be that the coral rudstone facies was developed either during relative lowstands of sea level.



Text-fig. 1-1.3: Sequential development of the composite Walbridge (Silurian-Devonian) and sub-Onondaga unconformity based on features displayed at Neid Road quarry. A) development of Wallbridge karstic subaerial unconformity; note development rhizomes of early vascular plants on exposed rock ground surface. B) mid-late Emsian sediments accumulate in low areas provided by solution hollows. Note proliferation of corals on high areas of the irregular topography

At this quarry these unconformities are dramatically exposed and both Bois Blanc and Edgecliff Member of Onondaga show local onlap onto an irregular erosion surface on upper Silurian Bertie and Akron formations or that the positive topographic relief exposed in the quarry is only the margin of a more elevated feature that is developed back of the wall or was destroyed during quarrying. The presence of tongues of rudstone to grainstone facies through a significant portion of the upper limestone ledge in the first outcrop to the northwest, and its presence in the top of the lower (Springvale) unit across the ramp road implies that a coral-rich community was developed locally during deposition of much of the Bois Blanc. This appears to support a suggestion that a greater topographic high, not seen in the quarry wall, existed



Text-fig. 1-1.3 (continued): evolution of the Wallbridge-Bois Blanc unconformities. C) late Emsian subaerial exposure following deposition of the Bois Blanc; note hypothetical colonization by small vascular plants. D) in latest Emsian to early Eifelian the composite erosion surface is re-flooded and blanketed by crinoidal debris and scattered corals of the lower Onondaga Formation.

locally, and that coral bioherm communities, reflected here in off-reef debris aprons draping the topography, may have existed locally over the high during much of Bois Blanc deposition. Curiously, reef development did not continue above the sub-Onondaga unconformity, as reflected by the relative finer-grained and coral-poor grainstones of the basal Onondaga, which is well known for its local biohermal buildups.

This is also very interesting in light of studies by Wolosz (1992) and Wolosz and Paquette (1988, 1994) on the nearby LeRoy Bioherm. They provide evidence that the lower core of the bioherm was subjected to extensive erosion prior to deposition of the upper cap of the feature. Recent regional to basinwide study of the Onondaga Formation indicates that the Edgecliff Member comprises two and a half medial-scale sea level cycles (parasequence sets). The erosion over the core could have occurred during one of the relative lowstands of sea level within the Edgecliff. However, in light of the discovery of Bois Blanc biohermal facies locally, another possibility is that the dark-colored, fine-grained, *Cladopora*-rich core of the reef also could be Bois Blanc. Oliver (pers. com., 2000) noted that *Cladopora* is a long-ranging Silurian-Devonian form; its presence in the lower part of the bioherm does not necessarily indicate an Edgecliff age. The diagenetic character of the partially-silicified cladoporids, unique among Edgecliff reefs (Wolosz and Paquette, 1994), is also consistent with the high degree of silicification of fossils in the Bois Blanc in western New York (Boucot and Johnson, 1968). Reworked clasts of cladoporid mound facies and otherwise absent lithologies in the base of the overlying biohermal unit and in fissure fills cut down into the inner reef core reported by Wolosz and Paquette (1994) appear to indicate a relatively significant break, consistent with exposure and erosion at a sequence-bounding unconformity. It is possible, then, that the erosion surface within the LeRoy Bioherm may actually represent the sub-Onondaga unconformity, and that the inner reef core is Bois Blanc in age, as tentatively suggested by Wolosz (1988).

OPTIONAL STOP - HONEOYE FALLS QUARRY

Stop Authors: Brett, Ver Straeten, Baird
Stop Leaders: Brett, Ver Straeten, Baird

Locality: Heidelberg Materials Quarry; Five Points Quarry General Crushed Stone Quarry, Honeoye Falls Plant just south of Honeoye Falls 6 Road (Co Rte. 63), just west of junction with Dalton Road; Honeoye Falls, Monroe County, NY; 42.947003, -77.632696 at entrance road off H.F 6 Road).

Stop Opt-a. Lower part of Honeoye Falls quarry. This relatively large and active quarry in the southeastern corner of Monroe County exposes an essentially complete section of the Onondaga

Limestone and lower strata of the Marcellus Shale subgroup, including the Cherry Valley Member (see Figure 3-5 of Brett and Ver Straeten, this volume). Strata in this quarry are slightly deformed (Alleghenian?), and rocks display a gentle dip roughly to the south at a steeper angle than the regional ~0.5° dip and there are local small folds. Two prominent sets of nearly vertical joints occur in the quarry; the middle portion of the Onondaga also shows a distinctive pattern of diagonal jointing with approximately 30º dip and oriented 080 to 50S.

The Honeoye Falls quarry is the only site in the western portion of the state that displays the entire Onondaga Formation (although the Edgecliff Member is only poorly exposed). The Onondaga Limestone at Honeoye Falls is typical of western exposures. The quarry is particularly notable for the unusually coarse facies of the Cherry Valley Member (Oatka Creek Formation) and for the distinctive channeling beneath it that in places chops out nearly the entire Union Spri1ngs Formation.

Mining operations work from several lifts in the Honeoye Falls quarry. The lowest rocks are exposed in a small, approximately 6.5 m deep sump pit in the northeast portion of the quarry. These rocks are rarely well exposed, commonly covered by water or by a muddy coating. The Upper Silurian (Akron Formation) - Devonian (Bois Blanc-Onondaga Formation) unconformity is reportedly present in the lower part of the pit (General Crushed Stone Corp. records) although, based on regional trends, we would estimate the contact to lie some meters below. The sides of the small pit are composed of the cherty upper Bois Blanc basal Edgecliff. The floor of the main quarry in the eastern part of the quarry (42.938645, -77.630438) is on a distinctive stratum rich in small (3-5 cm) diameter brownish gray bored phosphatic nodules and closely associated black chert nodules. This interval is interpreted a cherty facies of the "Springvale" interval, with reworked phosphatic nodules in a matrix of base Edgecliff Member limestone. In this case, following emplacement of the phosphatic clasts derived from underlying Bois Blanc (Emsian-Schoharie age sediments), black chert nodules developed within the sediment. The fact that these nodules have light chalky rims indicates that they are in situ (not reworked) and postdate the phosphatic clasts. "Springvale" is interpreted as latest Emsian in age. This bed is overlain by light gray, non-cherty crinoidal grainstone with occasional large crinoid columns and scattered corals of basal Edgecliff Member.

The walls of the overlying larger pit expose a complete section of the Edgecliff and Nedrow Member. The base of the Nedrow essentially formerly formed the floor of the large pit in the northeast area of the quarry. Overlying micritic limestones interbedded with more fossiliferous crinoidal wacke- and packstones are characterized by alternating light gray and dark cherts forming The middle part of the member features two distinctive subunits; lower, relatively coarse crinoidal pack- to grainstones with scattered corals, somewhat similar to the crinoidal grainstone facies of the Edgecliff Member, and a distinctive interval of greenish-gray argillaceous limestones and shales 2.8-3.4 m below the Nedrow-Moorehouse member contact.

The green shales are rich in coral and crinoid material. The top of the green argillaceous interval occurs at the top of the second wall and forms the base of the third main platform within the quarry, similar to the Stafford quarry. Ellipsoidal and elongate nodular to bedded cherts, which may feature dolomitic rinds, occur scattered throughout generally light gray micrites of the upper Nedrow. A prominent hackly dark chert bed 1.6 m above the green argillaceous interval is probably associated with a prominent, dark to black shale in the upper Nedrow noted widely throughout parts of New York and Pennsylvania and apparently represents the local signature of the lower Eifelian Chotek event.

The Moorehouse Member, as defined herein, begins 2.8 m above the base of the third lift and is relatively thick at this locality (ca. 17 m) Limestones in the lower portion of the member (ca. 5.5 m-thick) appear increasingly fine-grained, tabular and rhythmically bedded 9with about seven distinct bands, up to the level of the fourth lift. Nodular chert bands and several layers of bedded, hackly-breaking chert are common. Thin shaly to clay-rich interbeds are also found. Faunal diversity is rather low through the lower part of the Moorehouse.

The middle to upper parts of the Moorehouse at the Honeoye Falls quarry show a general coarsening-up trend. The upper part of the member is generally inaccessible in the high walls of the south face of the quarry, below the Onondaga Indian Nation bentonite (OIN=Tioga B of Way et al., 1986). Comparison with nearby sections indicate a rapid coarsening up above a thick, notably more argillaceous unit that occurs above the middle of the Moorehouse (this argillaceous unit is widely recognized across the Appalachian Basin throughout New York and Pennsylvania into at least northern West Virginia; see discussion in Brett and Ver Straeten, above). Where accessible, the upper beds of the member are highly fossiliferous and yield well preserved brachiopods and some crinoid crowns (particularly *Arachnocrinus*) on weathered surfaces. These strata represent the coarsest facies of the upper part of the Onondaga Formation.

Return to cars and proceed back up small ramp; retrace route to the high tanks .

Stop Opt-b. Upper part of Honeoye Falls quarry. The Tioga B (Onondaga Indian Nations bentonite) forms a prominent break within the quarry at the base of the overlying Seneca Member. The Seneca is characterized by 6.6 m of dominantly tabular wacke- to packstones with minor pale gray cherts. Thin clay-rich partings, most notably at 1.75, 3.05, 3.95, 4.7, and 5.4 m above the base of the Seneca, represent altered volcanic ashes (K-bentonites). The upper bed of the Seneca Member, which consists of relatively coarse crinoidal and brachiopod rich limestone, is capped by a sharp lithologic break with the overlying Union Springs Formation.

A thin, mm-scale black shale at the Onondaga-Union Springs contact overlies a relatively minor but widespread submarine unconformity across New York. Overlying strata comprise basal deposits of the Middle Devonian, siliciclastic-dominated Hamilton Group. Quarry operations in

1993-1994 exposed a fascinating cross-section of lower strata of the Marcellus Shale subgroup (see Figure 4-7 and text). The rock exposed comprises the Bakoven and Hurley Members of the newly redefined Union Springs Formation and the Cherry Valley and overlying black shale facies of the redefined Oatka Creek Formation. The Honeoye Falls quarry represents the westernmost known exposure of the Cherry Valley Member and underlying Union Springs strata in New York State (NOTE: terminology used for Marcellus strata above the Onondaga Formation in this field trip guide follows the stratigraphic revision presented in Ver Straeten et al. 2023).

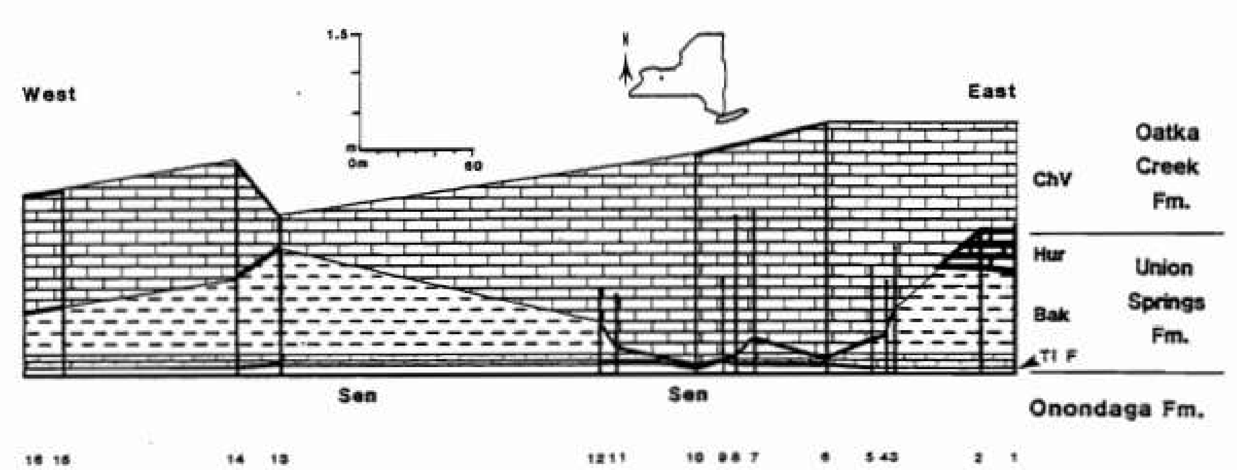
A 15 cm-thick, coarse, biotite-rich tuff of the Tioga F bentonite bed immediately overlies the thin layer of black shale at the Seneca-Bakoven Member contact. It is presently inaccessible. Overlying thin styliolinid limestones and black, platy, laminated shales of the Bakoven represent deposition under relatively deep, oxygen-starved conditions. A prominent phosphatic bone bed that yields abundant conodonts and fish remains, including onychodid teeth and dermal armor of arthrodires (discussed above) occurs within the package of thin limestones above the Tioga F. The Bakoven Member varies in thickness from 7 cm to at least 1.7 m along the outcrop as a result of extensive channeling along the discontinuity surface at the base of the overlying Cherry Valley Limestone.

A relatively thin, light-weathering, richly fossiliferous limestone found toward the eastern part of the Union Springs-Oatka Creek exposures represents the widespread Chestnut Street submember of the Hurley Member (Union Springs Formation). Pygidia and cephala of the proetid trilobite *Dechenella haldemanni* are the most diagnostic fossils from this unit. Also present are small to medium-sized brachiopods, auloporid corals, sponge spicules and tiny calyces of the crinoid *Haplocrinites*. The upper and lower contacts of this bed are sharply defined.

Along most of the exposure, the Chestnut Street Submember appears to have been removed, along with varying amounts of the underlying Bakoven Member by an extensive, channeled erosion surface that underlies limestones of the Cherry Valley Member. The Cherry Valley is extremely variable in thickness in this quarry, ranging from just over 40 centimeters upwards to over three meters along 300 meters of outcrop exposed in fall 1993-spring 1994 (Text-fig, 1-0pt.1). It is represented by a very atypical facies for the unit, which consists dominantly of crinoidal pack- to grainstones with lesser amounts of fenestrate bryozoan and styliolinid material. As previously stated, the basal surface of this unit is extremely irregular, and the Cherry Valley appears to fill low spots cut into the underlying Union Springs Formation. In contrast to most other localities, cephalopods are generally not particularly common at this location, although poorly preserved conchs of *Agoniatites* as well as some orthoconic nautiloids (e.g., *Striacoceras*) have been obtained. The upper surface of the Cherry Valley Member is also quite sharp and distinct; it commonly appears as a pyrite-coated corrosion surface. It displays an abrupt contact with overlying black shales assignable to the Berne Member.

To date, the highest beds observed in the quarry consist of barren, black, laminated shales with minor styliolinid hash beds. This interval at nearby localities (e.g., bed of Oatka Creek at LeRoy) features a richly fossiliferous bed of brachiopods and small corals that represents the first occurrence of the classic Hamilton Group fauna termed the Halihan Hill Bed (= gray bed or LeRoy bed of Baird and Brett, 1986); the Halihan Hill Bed has not as yet been found at the Honeoye Falls quarry and likely occurs in strata above the erosional contact of the Oatka Creek Formation with overlying glacial till deposits.

As previously noted, the basal contact of the Cherry Valley Member shows significant paleorelief across the quarry exposure, including distinctive channel-like structures. The cause of the channeling is unknown; in all other localities the Cherry Valley displays a nearly planar, although sharp, basal contact. We presume that the erosional scour was developed as a result of submarine channeling by gradient currents during a relative low stand in sea level. Similar erosional furrowing associated with maximum regression and subsequent earliest transgression has been observed at other localities in younger Middle to Upper Devonian strata (for example, see Brett and Baird, 1990).



Text-fig. 1-0pt.1 ss-section of the Marcellus subgroup at Honeoye Falls quarry, south of Rochester (Stop 2 of fieldtrip). Note erosional cutout of strata at base and top of Cherry Valley Member. Bold lines mark known thickness; thinner lines represent projected thickness.

Directions from Neid Rd. to Fall Brook:

0.0 mi	Head southeast on Neid Rd
700 ft	Turn right to stay on Neid Rd
0.33 mi	Turn left onto Gulf Rd
0.25 mi	Turn right onto Church Rd
0.92 mi	Turn left onto NY-5 E
0.22 mi	Turn right onto York Rd
2.33 mi	Continue onto McEwen Rd
0.78 mi	Turn left onto Black Street Rd
1.92 mi	Turn right onto NY-36 S
5.63 mi	Turn left onto Retsof Rd
1.61 mi	Turn left onto NY-63 S
3.87 mi	At the traffic circle, continue straight to stay on NY-63
2.1 mi	Pull over on side of road at stream crossing under road.

STOP 1-2A--FALL BROOK, GENESEO (LOWER PART)

Stop Authors: Kirchgasser, Over, Baird, Brett, Zambito
Stop Leaders: Over, Baird, Brett, Zambito

Locality: Exposures along the bed and banks of Fall Brook 0.2-0.6 km east of US 20A-NY. 39 and below Fall Brook Falls, Geneseo, Livingston Co., NY. (Geneseo 7.5' Quadrangle).
The steep banks prevent close investigation of Genesee strata. Stratigraphic relationships and fallen debris can be examined in the gorge, in place collections can be made from a side creek, Dewey Hill exposed on US 20A, and above the falls where strata are more accessible. **Caution:** large blocks have been known to fall from overhangs and strike eminent geologists.

References: Cooper, 1930; Baird, 1978; Baird and Brett, 1983; Brett and Baird, 1994; deWitt and Colton (1959, 1978) and Kirchgasser (1973, 1975).

Fall Brook below falls (Property is posted, access by permission only.), Town of Geneseo, US 20A west of village of Geneseo: Upper Moscow Formation of Hamilton Group, erosional base of Genesee Group, pyritic lag, dark colored petroliferous shales, interbedded carbonates, Givetian-Frasnian boundary, and major deepening of the basin represented by planktic-fauna carbonates. Windom Shale Member, Leicester Pyrite, Geneseo Shale, Penn Yan Shale, Genundewa Limestone.

Description of Units: Strata of the Moscow Formation (Hamilton Group) are exposed in the stream bed and banks below the falls. Fossiliferous bluish-gray shales of the Kashong Member are overlain by bioturbated fossiliferous medium gray calcareous shales and carbonate beds of the Windom Member and lower Garrattsville (new) members) (Text-fig. 1-2.1).

Kashong Shale Member: Low cut-banks along Fall Brook near U.S. 20A expose the upper 1.7 m of the Kashong Member. This unit comprises sparsely fossiliferous, bluish gray mudstone with abundant pyritic tubular bur- rows. Body fossils include large ramose bryozoans, the brachiopods *Lingula* and *Tropidoleptus* and rare *Dipleura* trilobites and phyllocarid fragments.

Windom Shale Member: The contact with the overlying Windom Shale Member is exposed here and consists of a calcareous mudstone band approximately 40 cm thick. This unit contains an admixture of reworked Kashong and Windom fossils and small phosphatic steinkerns and nodules. This heavily bioturbated sediment has been interpreted as a biogenically blurred unconformity or "stratomictic discontinuity" (Baird, 1978). The zone of phosphatic pebbles in the upper Kashong has been traced westward to Erie County, and is inferred to represent a widespread disconformity within the Moscow Formation [should the term Little Beards Creeks Bed be introduced here?] (Baird, 1978; Brett and Baird, YEAR).

Overlying the phosphatic pebble bed is typical basal Windom Shale: soft, medium gray shale (Cuylerville Submember of Brett et al. 2023) with abundant specimens of *Ambocoelia umbonata* (see supplemental data of Zambito et al., 2008 for a faunal abundance list for this interval at Fall Brook and other western and central New York localities).. Aside from the basal 30-50 cm, the lower 4.5 m of the Windom, are largely covered with slumped talus and are not accessible at Fall Brook. However, a total Windom thickness of 15.63 m was measured at this locality.

The Windom section continues upstream at the base of a high cliff face on the northern side of Fall Brook. The lowest unit exposed consists of medium gray, calcareous, and very fossiliferous mudstone. Abundant fossils include *Pseudoatrypa*, *Mucrospirifer*? *consobrinus*, *Protodouvillina*, the rugose corals *Stereolasma* and *Amplexiphyllum*, crinoid columnals and abundant *Eldredgeops* trilobites. This interval was traced into the Bay View coral beds of Erie County (Brett, 1974; Baird and Brett, 1983; Brett and Baird, 1994). This unit is gradationally overlain by a band of medium gray, calcareous shale and argillaceous limestone, approximately 40 cm thick, which forms a low falls in the creek bed. This is gradational above and below into less calcareous mudstone and contains abundant crinoid columnals in stringers, the small rugose coral *Stereolasma* and fragmentary and complete specimens of the trilobites *Eldredgeops rana* and *Greenops* sp. This band, the Smoke Creek Bed (or "trilobite bed"), has yielded clusters of complete trilobites, especially in Erie County (Speyer and Brett, 1985). Trace fossils in the form of pyritized sinuous burrows are very abundant in this zone. The unit, in turn, is gradationally overlain by gray calcareous and relatively fossiliferous mudstone with a fauna resembling that of Uni, which grades upward into darker, less fossiliferous shale. A very thin bed (bed f in Figure X) of corroded corals and brachiopod fragments marks a discontinuity within the Windom. This thin lag bed was found by former SUNY Geneseo professor James Scatterday to have very concentrated conodonts. Detailed study by D.J. Over revealed densities of icriodid conodonts up to 40,000 elements per kg together with small shark teeth.

A band of dark gray, relatively hard, fissile shale forms a slight projection in the bank in some areas about 8 m above the base of the Windom. This interval, a thin remnant of the Fisher Gully Submember, a very widespread dysoxic shale interval, contains abundant *Emanuella praeumbona* , large specimens of *Ambocoelia umbonata* and occasional *Eumetabolotoechia multicosta* and *Spyroceras*.

The Fisher Gully interval is overlain abruptly and probably erosionally, by a bed of crumbly medium gray mudstone packed with fossils including *Cystiphylloides*, *Heliophyllum* and other large rugose and tabulate corals, atrypid brachiopods (*Pseudoatrypa* and *Spinatrypa), Mediospirifer*, and at least 55 other species of invertebrate fossils. which occurs 8.57 m above the base of the Windom at Fall Brook has been designated the Fall Brook Coral Bed by Baird and Brett (1983). This fauna of the Fall Brook bed closely resembles that of the slightly older Bay View bed and indicates a recurrence of nearly identical environmental conditions under which coral biostromes developed widely in western New York. The Fall Brook bed has been traced from central Genesee Co., eastward to Seneca Lake a distance of approximately 90 km. Large rugose corals are restricted to a 30-40 cm thick band; other fossils, including small rugose corals (*Amplexiphyllum*, *Stereolasma*), the brachiopods *Pseudoatrypa*, *Mediospirifer*, *Protodouvillina* , abundant crinoid columnals and bryozoans persist upward for approximately 1.5 m into the overlying mudstone. This richly fossiliferous, but non-coral bed assemblage has been termed the Taunton beds by Baird and Brett (1993) The upper portion of the Taunton interval bears three zones of large calcareous non-septarian concretions. Fossil bands run continuously through concretions indicating a late diagenetic origin for these structures.

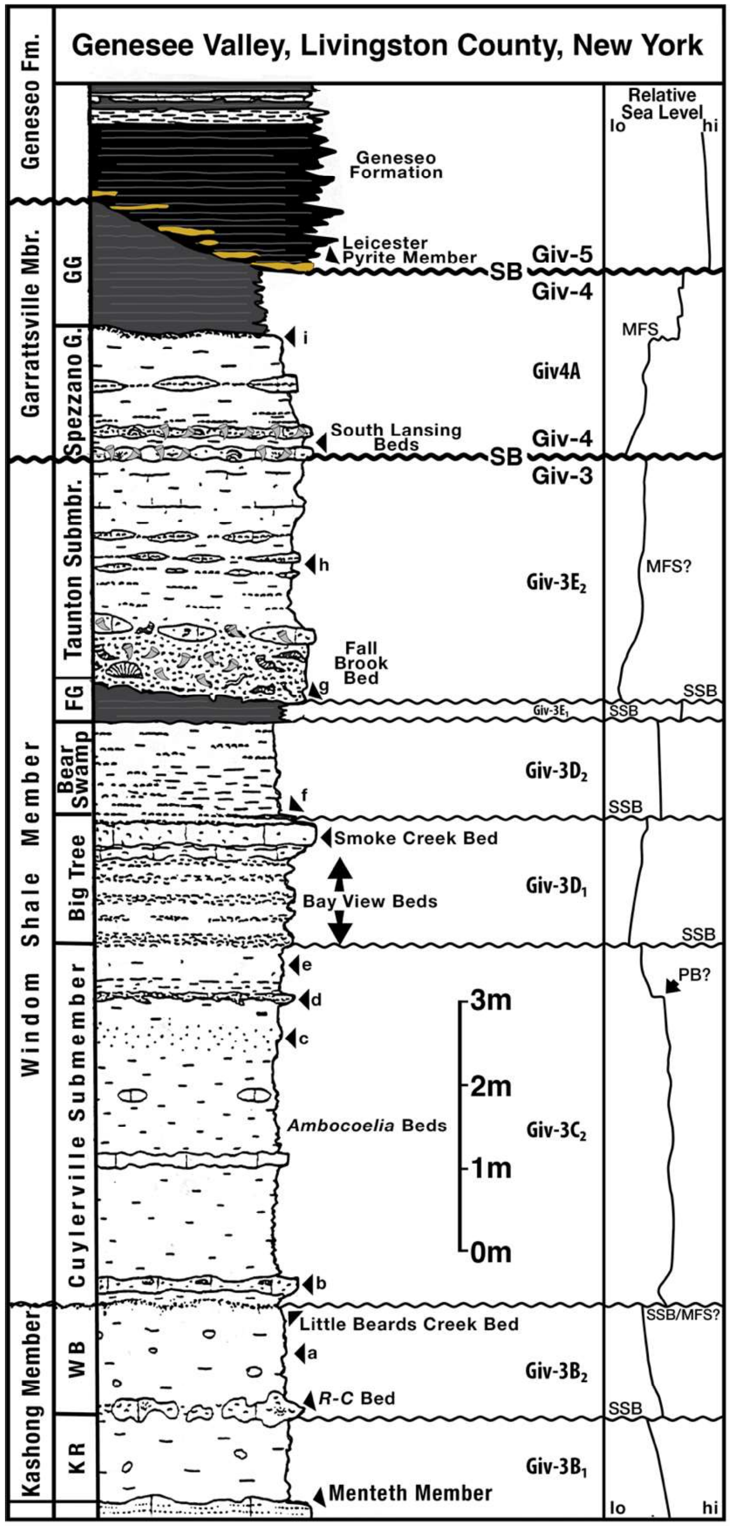
Garrattsville Member: Brett et al. (2023) proposed the name Garrattsville Member for an important upper interval of the Moscow Formation in central New York, with at the type section at Garrattsville, Otsego County. This interval, formerly assigned to upper Windom is in fact not present at the Windom type section in Erie County. Throughout much of its extent, this interval is bounded by a distinct bed or pair of beds with a very rich fauna termed the South Lansing Beds. A relatively thin portion of the lower Garrattsville interval persists into western New York about to the Genesee Valley.

A thin (30 cm band) of argillaceous limestone, the South Lansing Beds at the base of the Spezzano Gully Submember, contains abundant small rugose corals (*Stereolasma*) and a few atrypid brachiopods, and forms the base of the Garrattsville Member, about 11 m above the base of the Windom Shale at Fall Brook. This unit grades upward into dark gray, slightly calcareous petroliferous shale with abundant pyritic sinuous burrows and occasional nodules of pyrite and scattered fossils, including *Stereolasma* and *Pseudoatrypa*.
The upper beds of the Garrattsville at Fall Brook consist of very dark gray to black, fissile,

pyritic shale (Gage Gully beds). This shale is generally sparsely fossiliferous, but some layers contain abundant diminutive *Allanella tullia*, *Ambocoelia*, *Devonochonetes*, and, in a thin bed at the base, *Emanuella praeumbona.* A zone of pyritized fossils near the top of this interval has yeilded nuculid bivalves, the trilobite *Greenops boothi*, the nautiloid *Spyroceras*, and rare large specimens of the goniatite *Tornoceras* cf. *T. uniangulare*. The highest beds of the Windom are black, platey shale with *Allanella tullia*. The contact between these beds and the overlying Geneseo Black Shale is often difficult to recognize in the Genesee Valley area because of the lithology of the two units. However, the Geneseo is harder, weathers rusty and is more petroliferous than the upper Windom. The contact, here as elsewhere in western New York is sharp and unconformable. The entire Tully Formation and upper Moscow Formation are removed at this unconformity. It is overlain sharply by the Geneseo Formation of the Genesee Group.

<u>Genesee Group Succcession:</u> The Genesee Group consists of the Leicester Pyrite, Geneseo Shale, Penn Yan Shale, Genundewa Limestone (resistant bed forming the falls), and West River Shale. Most of this succession in inaccessible in the gorge as it is exposed in steep cliffs and in the face of the Fall Brook cascade.

Leicester Pyrite: The base of the Genesee Group is marked by the Leicester Pyrite, a 0-20 cm thick, sharp-based accumulation composed almost entirely of pyrite nodules, pyritized burrow fills, and pyrite replaced fossils that represents a condensed lag accumulation above a major disconformity. The type exposure of the Leicester is across the valley at Beards Creek north of Leicester, New York. In this region the Leicester carries a rich, shelly fauna of diminutive species of brachiopods, mollusks, echinoderms and crustaceans as described by Loomis (1903). The bed contains a mixed conodont and cephalopod fauna of Hamilton, Tully, and Genesee taxa (Figure 4). Pyritized cephalopods (*Tornoceras uniangulare and orthoceratids*), crinoids, bivalves, burrow fills and rare brachiopods and trilobites are present. The unconformity is the result of submarine erosion, corresponding to the Taghanic Onlap event (*sensu* Zambito et al 2012; Baird et al., 2023; see also Johnson 1970). The Leicester Pyrite is distinctive in weathered blocks due to the orange-brown weathered surface. *In-situ* lenses of Leicester Pyrite are seen at the disconformable contact between the dark gray Hamilton shales and the black Geneseo shale in the high north embankment north of the main falls. Cooper and Williams (1935) interpreted the Leicester Pyrite fauna as a modified Hamilton fauna. The Leicester is the type horizon of *Tornoceras* (*T.*) *uniangulare uniangulare* (Conrad) (described by House, 1965) of Fauna 12 (Kirchgasser and House, 1987). Huddle (1981) reports the conodonts *Palmatolepis disparalvea* , *P. ectypus* (= *P. cristatus*) and *P. dubius* in sample (sample 6677), indicating the *disparilis* Zone, the same age as the Leicester at Cayuga Creek (Stop 1-2). Farther east, at Gorham, the Leicester Pyrite lies between the Tully Limestone and the Genesee Formation and there Huddle (1981) reported conodonts of the Upper *hermanni* Zone (Klapper, 1981).



Text-fig. 1-2.1: Detailed stratigraphy and sequence stratigraphy of the Windom and Garrattsville members and submembers in the Genesee Valley, Livingston County, New York. Unit (cont.) abbreviations are Spezzano G. = Spezzano Gully Submember, FG = Fisher Gully (cont.) Submember, and GG = Gage Gully Submember. Letter units: a, uppermost Kashong Shale; b, unnamed trilobite-rich Windom concretionary bed; c, pyritic beds; d, Torpy Pond Bed or *Ambocoelia* "prod layer;" e, *Devonochonetes coronatus* beds; f, conodont-rich bed; g, erosional base of Fall Brook Bed; h, concretionary beds with crinoids or "*Clarkeocrinus* bed;" i, Simpson Creek Bed. Sequence stratigraphy abbreviations are MFS = Maximum Flooding Surface; PB = Precursor Bed (= forced regression surface); ssb = small (fourth-order) sequence boundary. Lo and hi represent low and high relative sea level, respectively. Modified and used from Brett and Baird (1994) with permission of the New York State Geological Association and Baird et al. 2023, with permission of PRI.

Leicester Member detrital pyrite, prefosilized debris, and nonpyritic insolubles are considered by Baird and Brett (1986) to have accumulated under the influence of episodic strong currents in a dysoxic to near anoxic basin setting below an inferred pycnocline. In this setting, exposed, reworked, carbonate bioclasts were selectively dissolved, leaving behind a placer of detrital pyrite, fish bones, conodonts, and rare quartz pebbles.

Occurrence of Leicester debris in laterally disconnected lenses along the disconformity contact reflects hydraulic concentration of debris within a series of parallel to sub-parallel channels on the regionally sloped substrate during inferred downslope debris transport (Baird and Brett, 1986). Occurrence of vertically stacked Leicester lenses, separated by basal Geneseo black shale partings is evidence for episodic, downslope transport of pyritic debris past the upslope onlapping limit of black mud deposition during the long duration of the Geneseo depositional onlap process. Westward-younging of Leicester debris (noted above) is strong evidence for an eastward-southeastward-facing basin-slope timed with Geneseo mud onlap (Baird and Brett, 1986).

Geneseo Shale - The Geneseo Shale gradationally overlies or is locally interbedded with the Leicester Pyrite. At its type section, at Fall Brook the Geneseo is 8.2 m thick (base of lower black shale to top of upper black shale), characterized by a lower 1.7 m thick and an upper 1.4 m thick dense black petroliferous shale units separated by 5 m of medium-dark gray shale and thin carbonate mudstone beds. [In deWitt and Colton (1978) only the lower black shale is considered to be the Geneseo.] The Geneseo black shale, being absent at Lake Erie, thickens eastward from Cazenovia Creek where it is ~60 cm thick, to about 30 m thick in the Finger Lakes.

At Fall Brook, Leicester lenses are overlain by a 1.7 m thick band of black shale comprising the lower tongue of the Geneseo Member. A similar band of black shale is seen above and the prominent argillaceous limestone in the interval between the two black shale bands is possibly the Fir Tree Limestone (Lincoln, 1897).

The continuous limestone band in about the middle of the gray Geneseo shale interval is the

Genesee Limestone (GL), with *Pharciceras* and a *disparali*s Zone conodont fauna that includes *Polygnathus linguliformis* gamma and *Po. dubius*.

Penn Yan Shale – The Penn Yan Formation consists of mixed medium and dark gray shale with thin silty limestone bands. The Lodi Limestone, forming the base of the Penn Yan, is a thin carbonate mudstone bed 1.2 m above the Genesee Limestone. In the Finger Lakes region, it is locally expressed as a diastemic surface marked by a pyrite-bone bed lag developed on the corroded surface of a condensed carbonate deposit (Baird et al., 1988). The Lodi Limestone, a nodular carbonate 1.1 m thick at the base of the Penn Yan, marks the local first occurrence of *Ponticeras perlatum* and *Skeletognathus norrisi*, indicative of the *norrisi* Zone, the latest zone of the Givetian. *Ancyrodella? rotundiloba* early form, which defines the base of the Frasnian and MN Zone 1 of Klapper (1989), and the Givetian-Frasnian boundary, occurs just above the Lodi Limestone east of the Genesee Valley (Kirchgasser, 1994).

The lower part of the Penn Yan gray shale succession is exposed in the side creek. Here, the Penn Yan Shale lies above the upper thick black shale of the Geneseo and is characterized by medium-dark shale and interbedded thin carbonate mudstones, styliolinid packstone/grainstones, and thin black shale beds. Huddle (1981) reports the conodont *Ancyrodella? rotundiloba rotundiloba* (sample 6698) indicating the start of the Lower *asymmetricus* Zone.

Genundewa Limestone - At the base of the main falls, loose blocks of the Genundewa Limestone yield rare baritic replacements of *Manticoceras contractum* of Fauna 17. Fauna 17 correlates with the Lower *Manticoceras cordatum* Zone (I beta). The horizon with *Manticoceras* in the Upper Genundewa is found in place in the Dewey Hill section.

At the top of the roadcut on the south side, there is a small exposure of the Genundewa Limestone and the topmost bed (Bed 19/10) yields a meager baritic fauna with *Manticoceras contractum*?, *Probeloceras* and *Tornoceras* of Fauna 17, which may indicate the *Manticoceras cordatum* Zone (I beta).

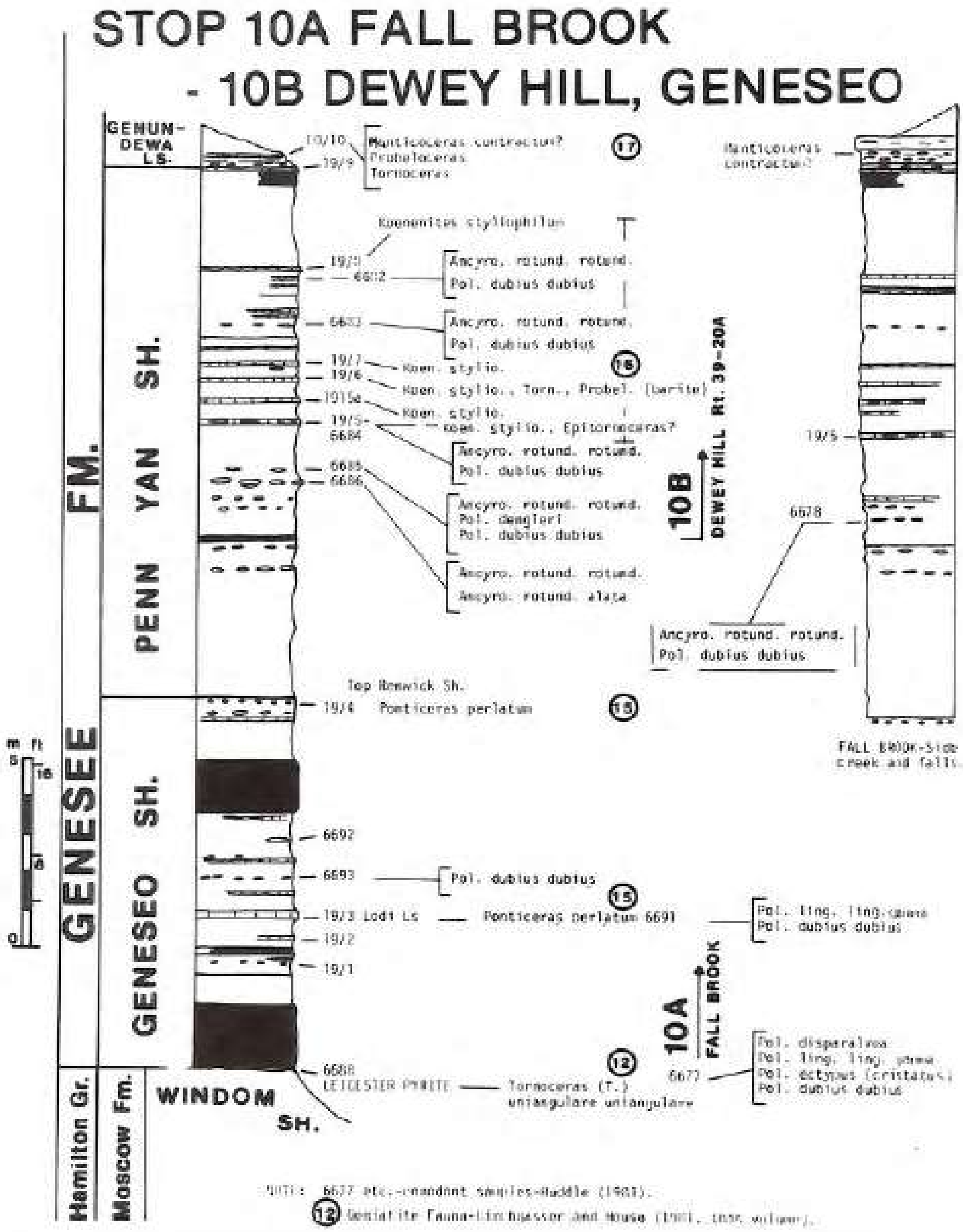
OPTIONAL STOP 1-2B: DEWEY HILL

Location/Units: Upper Penn Yan Shale and Genundewa Limestone (Genesee Fm.) exposed in road cut of Rt 20A/39, Dewey Hill, 2 km southwest of Geneseo, Livingston County. Continuation of section illustrated for Stop 10A. Geneseo Quadrangle, Livingston County. Text-fig. 1-2.2

Description of Units: The Dewey Hill roadcut includes strata through the middle and upper parts of the Penn Yan Formation encompassing the lower part of the Frasnian Stage, upward to the base of the Genundewa Limestone. This section is dominated by sparsely fossiliferous gray to black shale alternating with numerous concretionary beds and lentils upward to the Genundewa Limestone at the top (east) end of the cut. At the lower end, the Dewey Hill roadcut commences with a series of concretionary levels in the Penn Yan Shale from which Huddle (1981, samples 6686, 6685) recorded the conodonts *Ancyrodella? rotundiloba rotundiloba, A. rotundiloba alata* and *Polygnathus dengleri* of the Lower *asymmetricus* zone. This constitutes the lowest documented occurrence of Frasnian zonal indicators in the Genesee Valley region.

Productive horizons are a series of thin concretionary and styliolinid limestones (Beds 19/5 19/8) with Lower *asymnetricus* Zone conodonts (Huddle, 1981) and the goniatites *Koenenites styliophilum*, *Probeloceras* sp., *Tornoceras* sp. and *Epitornoceras* sp. of Fauna 16, an assemblage which correlates with the lunulicosta Zone (I alpha). Specimens are rare but the best fauna comes from Beds 19/5 and 19/6 (baritic replacements) on the south side of the road. The sequence of *Koenenites* beds of the upper Penn Yan is called the Linden Goniatite Horizon in reference to the productive horizon at Linden, Genesee County (Bed 15/8) (Kirchgasser and House, 1981, this volume, fig. Previously (House, 1968, Kirchgasser, 1973) thought that *Manticoceras* entered in the upper Penn Yan, but *Manticoceras* is now believed to enter in the Upper Genundewa.

The *Koenenites styliophilum* fauna (Fauna 16) is well developed farther east in the Crosby Sandstone around Keuka Lake and in levels below the Crosby at Seneca Lake (Stop 138, upper Lodi Glen), which suggests that the Crosby is not the eastern equivalent of the Genundewa (deWitt and Colton, 1959, 1978) but is a somewhat older horizon in the upper Penn Yan.



Text-fig. 1-2.2. Section of Genesee Group at Fall Brook and Dewey Hill, near Geneseo, New York. Revised from Oliver and Klapper (1981). USGS Samples Numbers (SD) from deWitt and Colton (1978) and Huddle (1981).

Directions from Fall Brook to Lower Taughannock Falls Parking Area:

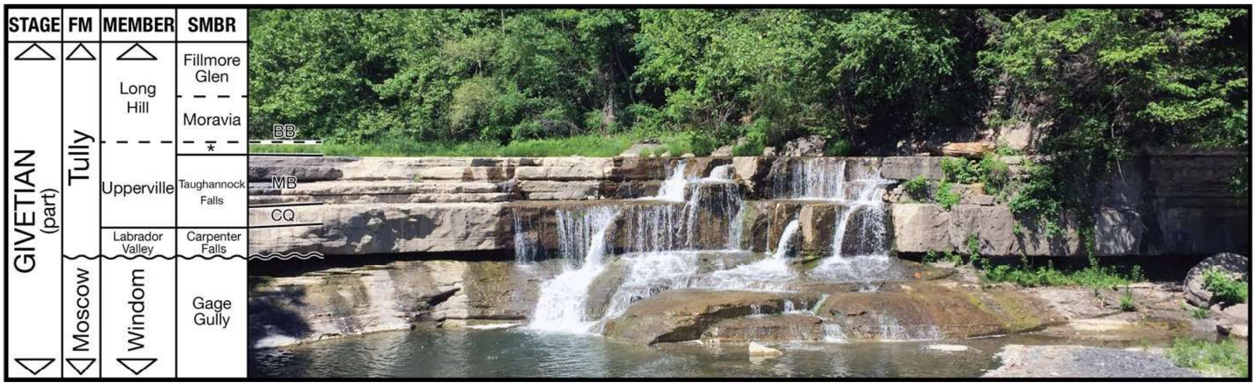
0.0 mi	Head north on NY-63 N toward US-20A W
0.74 mi	Continue straight onto US-20A E
0.72 mi	Continue straight onto South St
1.1 mi	Continue onto US-20A E/Lakeville Rd
3.82 mi	Turn left onto the ramp to Rochester
0.325 mi	Merge onto I-390 N
16.7 mi	Take exit 12 for I-90/NY-253/Lehigh Station Rd toward Thruway
750 ft	Keep left, follow signs for I-90 ThruwayToll road
0.6 mi	Keep left at the fork, follow signs for I-90 E/Albany and merge onto I-90 E
35.4 mi	Take exit 42 toward NY-14/Geneva/LyonsToll road
0.33 mi	Continue onto NY-318 EToll road
785 ft	Turn right onto NY-14 S
0.41 mi	Merge onto NY-96 S via the ramp to Waterloo
6.59 mi	Turn right onto N Virginia St
0.89 mi	Continue onto Washington St
0.31 mi	Turn right onto W River St
310 ft	Turn left at the 1st cross street onto NY-96 S/Fayette St Continue to follow NY-96 S
9.39 mi	Turn left onto White Rd
0.96 mi	Turn left onto NY-414 N
445 ft	Turn right onto Ernsberger Rd
2.35 mi	Turn right onto NY-89 S
19.0 mi	Turn right onto Taughannock State Park Access Rd. Destination will be on the right

STOP 1-3A: TAUGHANNOCK FALLS STATE PARK (LOWER CREEK SECTION)

Stop Authors: Baird, Brett, Zambito
Stop Leaders: Baird, Brett, Zambito

Location: Exposures at low waterfall (over Tully Limestone) about 0.5 km (1650 ft) upstream from mouth of Taughannock Creek and 150 m (500 ft) southwest of N.Y. Route 89, Tompkins Co., N.Y. (Ludlowville 7.5' Quadrangle).

Description of Units: The lower waterfalls on Taughannock Creek, about 4.5 m (15 ft) high, exposes the uppermost beds (about 2.5 m, 8.25 ft) of the Windom Shale and possibly the very base of the Garrattsville Member, sharply and unconformably overlain by the massive Tully Limestone, here totaling about 4.5 m (15 ft) thick. The creek bed above the falls exposes bedding planes in the Tully Limestone of Late Givetian (upper *Pol.ansatus* to "*O*".*semialternans*) (Text-fig. 1-3.1).



Text-fig. 1-3.1: Lower falls at Taughannock Falls State Park (Trumansburg, New York), type section of the Taghanic Crisis. Lower falls is approximately 6 m (19.7 ft) high. CQ = Carr's Quarry Bed, MB = Muller Brook Beds, BB = Bellona Bed, * = West Brook Shale Submember. Units above the top of the falls (provisionally placed on the figure) are accessible upstream and in the wooded area to the right. Image modified and used with permission of Jonathan Hendricks.

This exposure is well south of the main outcrop belt of the Moscow and Tully formations along the northern flank of the Fir Tree Anticline, a distal fold of the Alleghenian orogen and the Tully Limestone displays a gentle northerly dip along the face of the waterfall.

The upper Windom Shale, Taunton Submember, is highly fossiliferous, bluish gray, calcareous shale with numerous brachiopod-bryozoan coquinites. A bed containing sparse large rugose and tabulate corals appears to correlate with the coral-bearing limestone seen at Portland Point on the east side of Cayuga Lake. Upper, dark shales of the Garrattsville Member have been removed by pre-Tully erosion along the so-called Taghanic unconformity (note spelling - although the word is derived from Taughannock; see summary of spelling variations in Zambito et al. 2012). This contact represents base of major T-R cycle IIa of Johnson et al., 1985; and sequence Giv-5 of Brett et al. (2011).

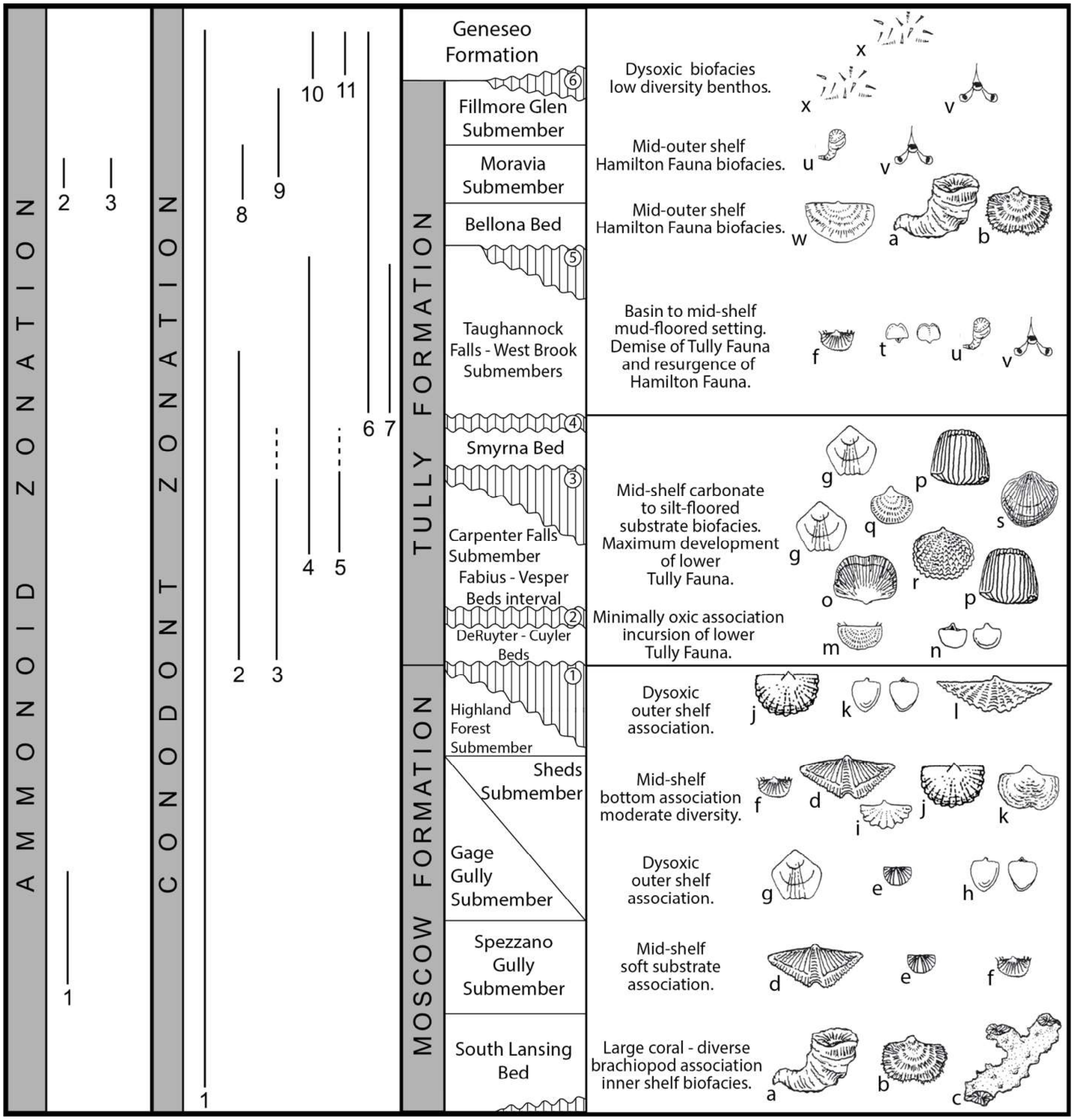
Heckel (1973) recognized several important subdivisions in the Tully Limestone, including two informal members. Recently the Tully Formation stratigraphy has been extensively revised by Baird et al. (2023). The lower part of the Tully, Shackham Brook Member, is absent here and the middle or Labrador Valley Submember is represented here solely by the Carpenter Falls Submember, a light gray biomicrite (wackestone) limestone. This interval shows the classic “Tully fauna” with such distinctive forms as *Tullypothyridina venustula, Emmanuella subumbona, and Ryssochonetes aurora.* This fauna represents a short-lived incursion of Cordilleran Old World Realm brachiopods see Baird and Brett, 2003; Zambito et al., 2012; others.

Unconformably overlying the Carpenter Falls bed is the basal unit of the Upperville Member, which Heckel termed the Taughannock Falls bed for its excellent exposures near the cap of this waterfalls. The unconformity, described in detail in Heckel, 1973 (and Baird and Brett, 2003, Baird et al., 2023) is considered to be a partially eustatic and partially tectonic sequence boundary Giv-5A to Giv-5B fourth order sequences of Brett et al., 2023.

This interval is a light gray argillaceous wackestone, but contains a fauna dominated by small rugose corals, atrypid brachiopods, and trilobites similar to associations in parts of the Moscow Formation. This unit is actually represented by several distinct beds, 30 to 50 cm thick hence Baird et al. (2023) referred to this interval as the Carr's Quarry bed and Muller Brook Beds of the Taughannock Falls Submember. This zone and is capped by-a very thin, shaly interval containing large rugose corals and favositids and diverse brachiopods, bryozoans and echinoderms, West Brook Submember. The Taughannock Falls interval records the extirpation of most of the "Tully fauna" (EE subunit 9 of Brett et al., 2009) and a dramatic return of many taxa typical of the "Hamilton fauna" (Brett et al. 2009; Zambito et al., 2012) (Text-fig. 1-3.2).

The fossiliferous shales of the West Brook interval is overlain sharply by a thin grainstone, the Bellona Bed at the base of the overlying Long Hill Member (or upper Tully). The overlying Moravia bed is somewhat lithologically and faunally similar to the Taughannock Falls Submember Baird et al. (2023) demonstrate that this is a repeated cycle with the Bellona Bed at its base. The boundary between the *ansatus* and *semialternans* conodont subzones lies within the Moravia bed.

Finally, the highest Tully unit, the Fillmore Glen Submember of the Long Hill Member,
This transitional unit between the Tully Limestone and overlying black Geneseo Shale is well exposed upstream of the low falls. Fillmore Glen of alternating nearly barren, dark brownish gray (white weathering), argillaceous limestones and dark gray shale beds. *Chondrites* burrows are abundant in both the carbonates and shales and are virtually the only fossils seen. The Fillmore Glen beds appear to grade upward into the hard, black, platy Geneseo Shale Formation, the lowest unit of the Genesee Group. This unit belongs to the *hermanni* Zone (Klapper, 1981). Hence, the upper portion of the upper Tully member (Moravia bed upward) appears to record the beginnings of the major late Middle Devonian transgression, termed the Taghanic Onlap (sensu Zambito et al., 2012; Baird et al., 2023). Westward from Cayuga Lake, the Tully appears to be separated from overlying Geneseo shales by a westward-widening erosional unconformity. This surface bevels the Fillmore Glen beds and eventually the remainder of the Tully Limestone. West of Seneca Lake a pyritic, bone-rich lag deposit (the Leicester Pyrite Member of the Geneseo Shale), rests on this disconformity, first on the bevelled Tully, then on the underlying Windom (Canandaigua Lake area westward;



Text-fig. 1-3.2: Generalized faunal succession in the upper Moscow Formation (newly proposed Garrattsville Member) and Tully Formation succession in central New York (Syracuse meridian) correlated to conodont and ammonoid zonation (from Zambitto et al., 2012, after Baird and Brett, 2003, 2008, with stratigraphic nomenclature updated using framework presented herein). This schematic shows the influx of the Tully Fauna at the base of the Tully Formation (DeRuyter Bed-level), reestablishment of the diverse Hamilton Fauna association in the upper Tully Formation (West Brook Submember/Bellona Bed-level), and the decline of faunal diversity in the highest Tully owing to the onset of transgression-related dysoxia in the Moravia Submember-Fillmore Glen Submember-interval. Key lowstand unconformities denoted in (cont.) circled numbers include: the base-Tully (1), base-Fabius Bed, Taghanic Unconformity

(2), base-Carr's Quarry-Smyrna Beds (3), and base-Bellona Bed/Taghanic Onlap (5) sequence disconformities. Maximum flooding surface contacts include: the top-Smyrna Bed unconformity (4) and the top-Fillmore Glen corrosional discontinuity (6). Diagnostic and/or common taxa include: a, *Heliophyllum halli* (Edwards and Haime, 1859); b, *Spinatrypa spinosa* (Hall, 1843); c, large bryozoans; d, *Mediospirifer audaculus* (Conrad, 1842); e, *Allanella tullia* (Hall, 1867); f, *Arcuaminetes* (*Devonochonetes*) *scitulus* (Hall, 1857); g, *Eumetabolatoechia alaura* Sartenaer, 2014 (in the Tully, this taxon is largely restricted to the clastic Gilboa Formation equivalents in eastern New York and Pennsylvania); h, *Emanuella praeumbona* (Hall, 1857); i, *Pustulatia* (*Vitulina*) *pustulosa* (Hall, 1860); j, *Tropidoleptus carinatus* (Conrad, 1839); k, *Athyris spiriferoides* (Eaton, 1831); l, *Mucrospirifer mucronatus* (Conrad, 1841); m, *Rhyssochonetes aurora* (Hall, 1867); n, *Emanuella subumbona* Hall, 1867; o, *Schizophoria tulliensis* (Vanuxem, 1842); p, *Tullypothyridina venustula* Sartenaer, 2003; q, *Echinocoelia ambocoeloides* Cooper and Williams, 1935; r, *Spinatrypa* sp.; s, *Pseudoatrypa devoniana* (Webster, 1921); t, *Ambocoelia umbonata* (Conrad, 1842); u, small rugosan; v, auloporids; w, *Leptaena rhomboidalis* Wahlenberg 1818; x, styliolines. Key conodonts include: 1, *Latericriodus latericrescens latericrescens* Branson and Mehl, 1938; 2, *Polygnathus timorensis* Klapper, Phillip, and Jackson, 1970; 3, *Polygnathus ansatus* Ziegler and Klapper, 1976; 4, *Tortodus caelatus* (formerly *Polygnathus beckmanni*) Hinde, 1879; 5, *Polygnathus alveoposticus* Orr and Klapper, 1968; 6, *Icriodus difficilis* Ziegler and Klapper, 1976; 7, *Polygnathus varcus* Stauffer, 1940; 8, "*Ozarkodina*" *semialternans* (Wirth, 1967); 9, *Schmidtognathus latifossatus* (Wirth, 1967); 10, *Polygnathus cristatus cristatus* Klapper, 1989; 11, *Klapperina disparalvea* (Orr and Klapper, 1968). Key goniatites include: 1, *Tornoceras* cf. *uniangulare* Conrad, 1842; 2, *Pharciceras amplexum* (Hall and Clarke, 1888); 3, *Epitornoceras* (*Tornoceras*) cf. *arcuatum* (Hall, 1879). Modified from Baird and Brett (2003, 2008), from Baird et al. (2012, fig. 2, p. 123), Palaeogeography, Palaeoclimatology, Palaeoecology, © Elsevier, used with permission; also Baird et al., 2023.

Windom Shale Member: see discussion of Fall Brook, stop 1-2A. However, no trace of the Leicester has been identified at Taughannock Falls, where the Fillmore Glen-Geneseo sequence appears conformable.

Overall, this locality shows the western, purer limestone facies (skeletal calcilutite/wackestone) of Tully Formation members, which differ little from one another in this region, but stand in stark contrast to the underlying upper Hamilton (Windom) shale. This contact represents a long-term sediment starvation with submarine erosion, as shown here by basal protuberances that probably represent burrow casts. The distinctive brachiopod *Tullypothyridina* occurs locally in the base. Faint discontinuity surfaces noted above at several levels in the Labrador Valley Member (all Carpenter Falls Submember) attest to cessation of carbonate mud deposition without settling of clays, suggesting submarine erosion probably due to organic activity in conjunction with weak currents. The widespread exposure surface between the Labrador Valley and Upperville members is not distinct here as it is to the northwest or northeast, but this section is the southernmost studied, and may have been somewhat lower in the Appalachian Basin during deposition. The Bellona Coral Bed also contains the fewest corals of any of the western sections, perhaps for the same reason.

Directions from Lower Taughannock Falls to Upper Taughannock Falls parking area

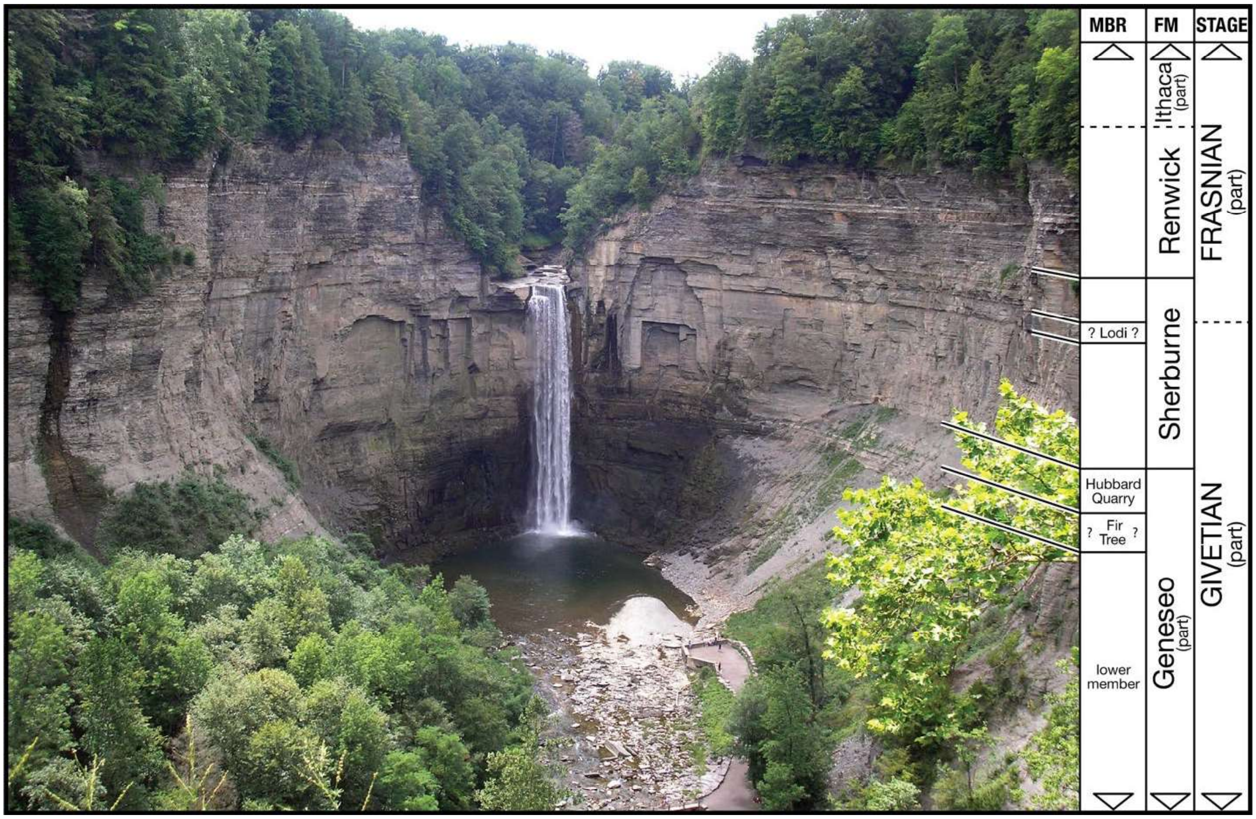
0.0 mi	Depart Lower Taughhannock Falls Parking Area, turn left onto NY-89N
0.33 mi	Turn Left onto Taughannock Park Rd.
0.74 mi	Turn left into Upper Taughannock Falls Parking Area

STOP 1-3B: TAUGHANNOCK FALLS STATE PARK (OVERLOOK)

Location: Taughannock Falls Park overlook on north side of Taughannock Creek about 1 km (0.6 mi) southwest of N.Y. Route 89, Tompkins County, N.Y. (Ludlowville 7.5' Quadrangle, 1942).

Description: This overlook provides a spectacular view of the 66 m (216.5 ft) upper Taughannock Falls, a hanging valley at the end of a 1.3 km (1 mile) long post- glacial gorge. Gorge walls up to ~120 m (~400 ft) high, expose shales and siltstones of the lower Genesee Group of latest Middle (Givetian) to early Late Devonian (Frasnian) age (Text-fig. 1-3.3). The configuration of the falls is controlled by prominent jointing; the lip of the falls is likely associated with the resistant (somewhat calcareous) siltstone beds of the Lodi Member, which at this locality are part of the Sherburne Formation. An interesting side note at this outcrop is the occurrence of thin (1-2 cm) dikes of Mesozoic kimberlite-like (alnoite) intrusive rock that crop out in the stream bed at the base of the falls.

Four formations within the Genesee Group are recognized at the overlook of the upper Taughannock Falls. Black shales of the Geneseo Formation form the lowest exposed unit; the plunge pool level is about 3.8 m (12.5 ft) above the base of this member, the gradational contact with the Tully Formation (Fillmore Glen Submember of the Long Hill Member) being exposed downstream (see Stop 3A). The upper contact of the Geneseo Formation is slightly more than halfway up the face of the falls, ~43 m (~140 ft) above the plunge pool and can be recognized by a change in coloration, bedding, and jointing. The Geneseo is nearly barren, platy to fissile black shale; it is largely covered by talus at the base of the gorge walls. Silty sandstone beds near the top of the Geneseo Formation at this locality are likely correlative with the Fir Tree Member (Fig. X). Across Cayuga lake along the railroad cut and in the nearby Cargill #17 core, the Fir Tree is an interval of silt-to-sandstone with abundant pyrite (Baird et al 2023). In more distal localities, the Fir Tree is an interval of auloporid coral-bearing carbonates (Baird and Brett, 1986, 1988; Baird et al. 2023). Based on this recognition of the Fir Tree, the uppermost shale of



Text-fig. 1-3.3: Lower falls at Taughannock Falls State Park (Trumansburg, New York. Upper falls lip is approximately 66 m (216.5 ft) above plunge pool, and the top of the Tully Formation is just below the plunge pool floor. Position of Fir Tree and Lodi members are estimated from study of the railroad cut across Cayuga Lake and the Cargill #17 core.

the Geneseo Formation is the fissile black shale of the Hubbard Quarry Member (Fig X; Baird and Brett 1988, Baird et al 2023), whose type section occurs approximately 13 km to the northwest. The Fir Tree and Hubbard Quarry members contain conodonts of the late Givetian *disparilis* Zone (Baird et al. 2023, and references therein).

The Sherburne Formation is about 35 m (~115 ft) thick and forms neat vertical, strongly jointed bluffs below and above the lip of the falls. The Sherburne is predominantly comprised of turbiditic siltstone-to-sandy siltstone and interbedded gray shale. An interval of ~7.5 m (~25 ft) at and above the lip of the falls is likely the Lodi member, an auloporid coral-bearing, calcareous siltstone in the Cargill #17 Core and at Twin Glens across Cayuga Lake (see Zambito et al. 2009 for a more detailed faunal list), and regionally bears the diagnostic goniatite *Ponticeras perlatum* and conodonts indicative of the *norrisi* Zone (Kirchgasser, 1994; Baird et al. 2023 and references therein). To the west, lag deposits indicating the removal of the Lodi Member yield Frasnian conodonts (*Ancyrodella rotundiloba* early form) as summarized in Baird et al (2023) and references therein. At the upper Taughannock Falls, the Middle-Upper Devonian boundary is therfore probably at, or slightly above, the lip of the falls.

In the upper cliffs, starting at about 11 m (~36 ft) above the level of the falls lip, the Renwick Formation can be observed. It consists of dark gray, rusty weathering shales with thick, light gray, highly convoluted and channel-form turbiditic siltstones. As seen in Figure X, the silstones within the Renwick are mostly lenticular to the left of the upper falls and more continuous on the right side; this indicates that the channel orientation is approximately NNW-SSE and the sediment source to the southeast (see Zambito et al., 2009). The Renwick Formation is an important (transgressive) stratigraphic marker in the lower Frasnian succession as it represents a brief pause in Catskill Delta progradation. The highest beds at the top of the gorge, partially obscured by vegetation, are brownish gray weathering siltstones of the Ithaca Formation. Strata of the Ithaca Formation are easily accessible upstream, where Jacksonville Road (County Road 143) crosses Taughannock Creek.

Discussion: The Geneseo represents a major deepening event associated with the Taghanic onlap. This transgressive event, occurring near the end of the Middle Devonian, is recognizable nearly worldwide and is almost certainly eustatic in nature, though locally accentuated by basin subsidence concurrent with the onset of a major Acadian tectophase (see Baird et al., 2023). In New York it is associated with widespread black shale deposition indicating anoxic bottom waters. The Fir Tree and Lodi intervals (recording sequence boundaries and onset of subsequent transgressions) record brief interruptions in the anoxia allowing colonization of the sea floor by a low diversity benthic fauna, such as auloporid corals, small brachiopods, and mollusks. Conversely, the Hubbard Quarry Member and Renwick Formation, reflect a return to deeper dysaerobic water conditions associated with intervals of maximal sea level rise. Superimposed upon these fluctuations of aerobic/anaerobic water masses was an overall increase in silty turbidites (lithofacies of the Sherburne Formation) as a result of Catskill Delta progradation.

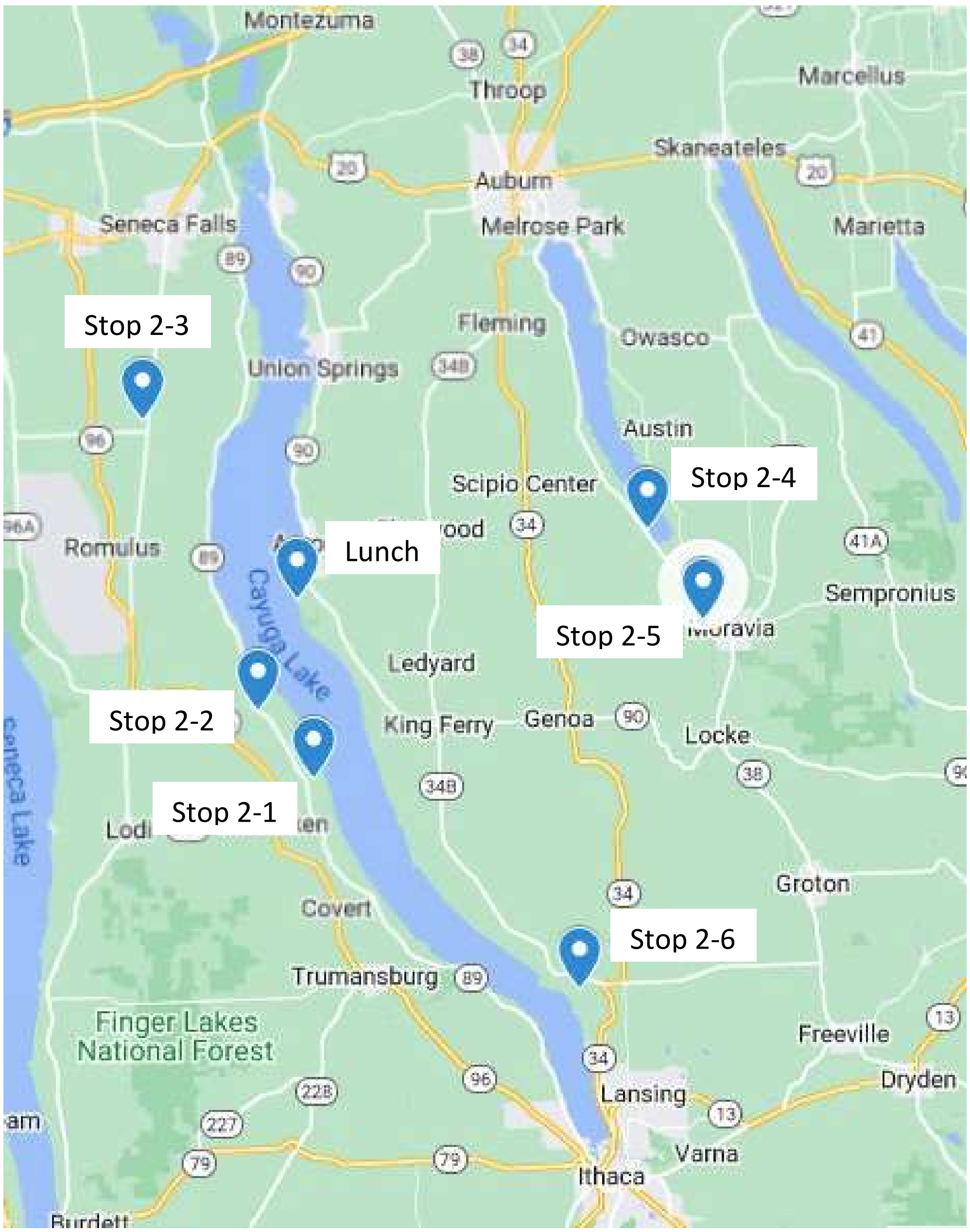
Directions from Upper Taughannock Falls to the Museum of the Earth at PRIField

0.0 mi	Depart Upper Taughannock Falls Parking Area, turn left onto Taughannock Park Rd.
0.35 mi	Continue onto Jacksonville Rd.
0.23 mi	Turn left to stay on Jacksonville Rd.
1.71 mi	Turn left onto NY-96S/Trumansburg Rd.
4.95 mi	Turn Left into the Museum of the Earth/PRI parking area

END DAY 1

Field Trip Day 2 – 8/3/2023

Stop 2-1	Hubbard Quarry
Stop 2-2	Grove’s Creek
Stop 2-3	Fayette Town Quarry
Lunch Stop	Stony Point/Long Point State Park
Stop 2-4	Cascade Cuts
Stop 2-5	Long Hill Road
Stop 2-6	Portland Point RR Cut



Ithaca Quality Inn to Hubbard Quarry:

0.0 mi	Depart Quality Inn Ithaca. Turn Left onto Elmira Rd.
0.54 mi	Continue onto S. Meadow St.
0.875 mi	Turn Left onto W. Buffalo St.
0.2 mi	Turn Right onto NY-89 N/Taughannock Blvd. Continue to follow NY-89 N
18.3 mi	Turn right onto Deerlick Springs Rd.
0.2 mi	Hubbard Quarry Locality

STOP 2-1: HUBBARD SHALE QUARRY (OPTIONAL)

Stop Authors: Baird, Brett
Stop Leaders: Baird, Brett

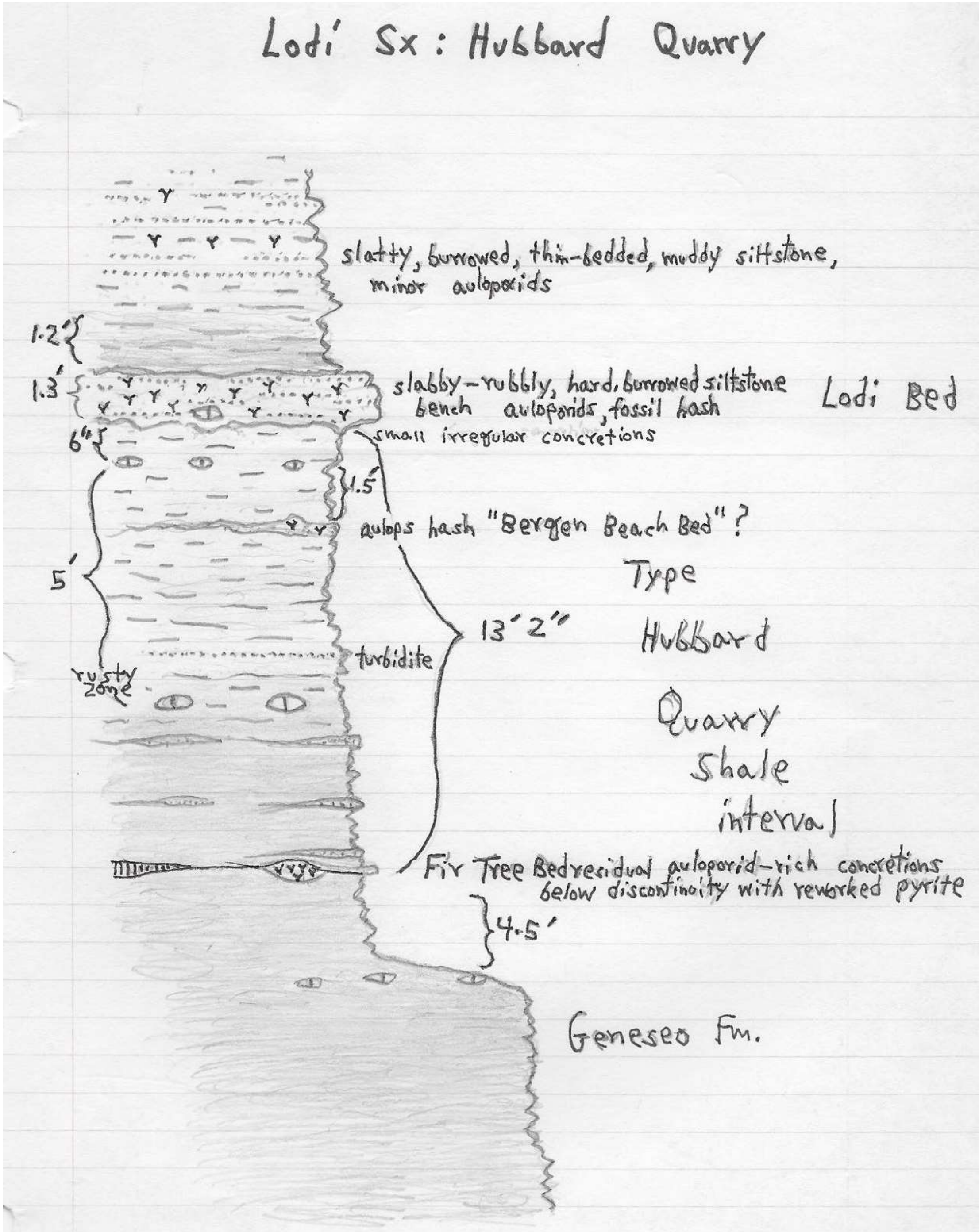
Locality: Small shale pit on east side of N.Y. Rt. 89 and about 0.3 km (0.2 mi) north of bridge over Lively Run Creek, town of Interlaken, Cayuga County, N.Y. (Sheldrake 7.5' Quadrangle, 1971).

References: Kirchgasser (1981), Baird and Brett (1986). Text-fig. 2-1.1

Description of units: The floor of this shale pit exposes very dark gray to black, platy shale of the Geneseo Formation. A layer of tabular, rusty-stained carbonate concretions containing auloporid corals is exposed near the lowest (northeast) end of the quarry. This is the northern feather edge of a concretionary carbonate, the Fir Tree Member which is represented at Taughannock Falls to the south by interbedded gray mudstone and concretionary siltstone layers and to the southeast by an interval of silt-to-sandstone with abundant pyrite. Here the unit is condensed and has been almost completely truncated by submarine erosion. This shale belongs to the *disparilis* Zone (Baird et al. 2023, and references therein)

The overlying black, fissile shale, here about 4.3 m (14 ft) thick, has been designated the Hubbard Quarry Member (Baird and Brett, 1986), it contains bedding planes covered with the flattened specimens of *Eumatbolotoechia* sp. and *Orbiculoidea lodiensis*. Two or three horizons of large septarial concretions containing calcite- and barite-filled fractures appear in the upper part of this division.

The Hubbard Quarry Shale is overlain by a nodular silty limestone and calcareous siltstone with very abundant auloporid corals, which is the local representation of the Lodi Member, marking the base of the Sherburne Formation. As noted at Taughannock Falls, the Lodi Member belongs to the uppermost Givetian *norrisi* Zone slightly below the Givetian/Frasnian (Middle/Upper Devonian) boundary. Kirchgasser (1981) reports *Ponticeras perlatum* in the concretionary bands of the Lodi Member.



Text-fig. 2-1.1: Stratigraphic section for Hubbard Quarry drafted by Gordon Baird.

Hubbard Quarry to Groves Creek:

0.0 mi	Head west on Deerlick Springs Rd. toward NY-89 N
0.2 mi	Turn Right onto NY-89 N
2.9 mi	Pull over on side of NY-89 N. walk up Groves Creek

STOP 2-2A. GROVES CREEK AT OAK TREE FALLS
Stop Authors: Brett, Baird
Stop Leaders: Brett, Baird

Location: Creek bed and banks above Oak Tree Falls on Groves Creek, just south of Wyers Point Road, town of Sheldrake, Cayuga County, NY (Sheldrake 7.5' Quadrangle): uppermost Ludlowville Formation (Jaycox mudstone), Tichenor Limestone, Deep Run and Menteth members of the lower Moscow Formation. 42.676636, -76.729662

Description of Units: The brink of this 10 m high waterfall is held up by silty, *Zoophycos*-churned mudstone of the lower Jaycox Member; these beds appear to pass laterally, within about 2 km into siltstones of the Owasco Member. The 30 cm thick Tichenor Limestone is recessed back from the falls lip but forms a small step in the creek bed. It consists of crinoid and shell-rich grainstone. Its base is erosional and detailed mapping (Mayer et al., 1994) reveals southeastward truncation of the upper Jaycox mudstone at this sequence boundary.

The overlying Deep Run comprises about 1.5 m of *Zoophycos* churned silty, calcareous mudstone. This unit has yielded large bivalves and articulated bivalves. The overlying Menteth Limestone Member displays a sharp, erosive base (*interpreted as a sub-sequence boundary). It is a thin 15-20 cm ledge-forming, silty limestone. This unit is exposed in a low step at the point where a dirt farm road crosses Groves Creek.

This succession rather closely resembles the lower Moscow beds in Genesee Valley to the west. However, this is due to mirror image telescoping of beds in shallow water areas on either side of the basin center (central Fingers Lakes area at present).

STOP 2-2B. GROVES CREEK, UPPER WATERFALL SECTION IMMEDIATELY EAST OF RT. 89

Locality: Small waterfall along Grove Creek, immediately SW of the junction of Rt. 89 and Description. The bridge of Rt. 89 over Groves Creek rests on Tully Limestone. The sharp contact of the Tully with the Hamilton is prominent. Windom Shale forms the face of the 30' high waterfalls on Groves Creek. This entire section is in the middle Givetian *ansatus* Zone (42.6726, -76.7382).

Description of Units: The coral and bryozoan rich Lansing beds at the of the Spezzano Gully Submember, base Garrattsville Member are prominently exposed in the creek bed; these beds feature diverse brachiopods, stick bryozoans and small fistuliporoid mounds. These pass upward into interbedded calcareous gray shale with thin fossil hash beds and stringers rich in atrypid brachiopods and small rugose corals. A thin but distinctive bed with the index brachiopod *Emanuella praeumbona* occurs about a meter above the creek floor, marking the base of the Gage Gully Submember but most of the upper black Gage Gully shale has been removed by the sub-Tully unconformity.

The Tully Limestone, also of *ansatus* Zone age, here comprises mainly the massive Carpenter Falls Submember, largely a sparsely fossiliferous micritic limestone.
GCB, JZ, CB

Groves Creek to Faytette Town Quarry:

0.0 mi	Continue North on NY-89 N
6.75 mi	Turn Left onto Ernsberger Rd.
2.35 mi	Turn Right onto NY-414 N
3.2 mi	Turn Left onto Poorman Rd.
0.3	Turn Left into Fayette Town Quarry

STOP 2-3: FAYETTE TOWN QUARRY
Stop Authors: Brett, Baird
Stop Leaders: Brett, Baird

Locality: Exposures in shale pit 0.1 km south of Poorman Road, 1.0 km (0.6 mi) west of intersection with N.Y. 96, town of Fayette, Seneca County, N.Y. (Romulus 7.5' Quadrangle, 1953).

References: Cornell University (1959), Kramers (1970), Gray (1984), Patchen and Dugolinsky (1979).

Description of Units: This old road-metal quarry (recently used as a dump) exposes the upper 12 m (40 ft) of the Skaneateles Formation: Levanna Shale Member, Butternut Member (2.5m) and about 6 m (20 ft) of the overlying Ashantee Member (formerly termed lower Centerfield) in facies transitional to the Chenango Siltstone/Sandstone (Figure); the contact is exposed in a bluff in the western part of the quarry. Text-fig. 2-3.1

Skaneateles Formation

Levanna Shale Member: The Lowest units, exposed near the entrance to the quarry, are dark gray shales with a few thin *Styliolina* -rich layers. These shales bear a sparse fossil assemblage of small bivalves, cephalopods, and, at some levels, leiorhynchid brachiopods. A lower band, apparently equivalent to Cooper's lower *Eunella-Nyassa* bed of the Rockefeller Road Beds, upper Pompey Member (Pratts Falls Submember of Brett et al. 2023) contains septarian concretions, with fossil brachiopods and mollusks. Surrounding shales are medium to dark gray with abundant small brachiopods (particularly chonetids, *Ambocoelia*, *Mucrospirifer*, and *Eumetabolotoechia*), flattened nuculid clams, nautiloids, gastropods, and rarely, *Eldredgeops* trilobites. A second concretionary band occurs about 1.5m higher and is also rich in *Ambocoelia*, *Mucrospirifer* and chonetids. This is likely the upper *Nyassa* or top Rockefeller Road bed. About 1.2 meters of soft, fissile shales separates this concretionary bed from the base of a pair of higher shell-rich beds.

Near the top of the excavated interval along the south excavated face of the pit, the shale contains two additional calcareous mudstone horizons, separated by about a meter of fossiliferous shale. This pair of limestone beds form a very widespread unit, termed the Slate Rock Submember, from exposures on Wilson Creek at Slate Rock Road south of Geneva; it has been traced westward to Genesee County and eastward to the vicinity of the Limestone Creek Valley where it forms the capping bed of Cooper's (1930) Pompey Member. It is everywhere, highly fossiliferous and represents a condensed shell bed.

A continuous 10 cm thick bench of fossiliferous, burrowed, argillaceous limestone occurs about 3 m (8' ft) below the basal contact of the Centerfield Member (Figure 6). This unit contains very abundant, commonly disarticulated brachiopods, especially *Ambocoelia* and *Mucrospirifer*, and mollusks, together with much unrecognizable fossil debris. The basal surface of the bed is concretionary (diagenetically cemented) and shows abundant, light gray colored *Chondrites* burrows extending downward into underlying dark shale. The upper surface of the bed shows a sharp contact with overlying black shales of the Butternut Member.

Butternut Member: The Butternut Member is mainly dark gray to black, fissile shale with a sparse *Eumetabolotoechia* (leiorhynchid) fauna; this 3 m (10 ft) interval is the direct lateral equivalent of the Butternut Shale Member, which attains thicknesses of over 60 m (200 ft) in the type area near Syracuse. This very dark shale appears to record the strongest deepening event within the Skaneateles Formation. Its sharp lower boundary on the Slate Rock bed records sediment starvation associated with rapid transgression. The Butternut-equivalent portion of the Levanna is exceptionally thin at Fayette, perhaps because of minimal sedimentation near the basin center, truncation of the top of the shale by pre-Centerfield erosion, or both.

Ashantee Member: The Ashantee member (formerly lower Centerfield) is incompletely represented at this locality by about 6 m (20 ft) of gray, fossiliferous shale and blocky, calcareous mudstone; there is little true limestone in the outcrop. The base of the member, here as elsewhere in the Cayuga Lake area, is probably a subtle discontinuity; a 2-3 cm thick fossil debris bed containing rare specimens of the brachiopod *Cyrtinoides* (formerly) *Mucroclypeus* Goldman and Mitchell and other small brachiopods, rests sharply on dark, fissile Butternut) shales. This is the lateral equivalent of the Peppermill Gulf bed of central New York and is a distal example of a "precursor bed" which lies at the base of an abruptly upward shallowing succession. The lower Ashantee comprises about 40 cm (1.3 ft) of gray slightly calcareous shale with very abundant and diverse fossils especially small rugose corals, brachiopods, crinoid debris, and abundant small *Eldredgeops* and *Greenops* trilobites. About 50 to 75 cm (1.7 to 2.5 ft) above the base is an interval containing very scattered, large rugose corals, heads of Favosites, and well preserved articulated *Spinocyrtia* brachiopods. Higher beds of buff-weathering, calcareous mudstone are very sparsely fossiliferous but contain a diverse assemblage of Large brachiopods, especially *Tropidoleptus, Meristella, Nucleospira,* and *Mucrospirifer* and the domical tabulate coral *Pleurodictyum*; these beds are heavily bioturbated by *Zoophycos*.

Such facies contrast markedly with the coral-rich shales and limestones of the type Ashantee member further west (see Browns Creek) but are very similar to Deep Run and Kashong mudstones of the lower Moscow Formation (see Stop 8A). They are interpreted as rapidly deposited, fine carbonate and siliciclastic muds derived from winnowed, shallow water areas flanking a central trough or basin axis. Thus, they represent slightly deeper water and considerably more turbid environments than do coeval coral rich beds, to the west. To the east these calcareous mudstones grade Laterally into thinner siltstones and cross- bedded fine sandstones of the Chenango Member; hence this facies belt is flanked by winnowed carbonate and siliciclastic sands on the west and east respectively. Despite their paucity, fossils are diverse and large. This suggests that most environmental parameters were amenable to a shallow water fauna but that settlement on the sea floor was inhibited by soft, unstable substrates.
Discussion: This quarry reveals evidence for two major cycles of deepening and shallowing. The first is represented by the Lower dark Levanna passing upward into the Slate Rock bed. This cycle culminates in gray, calcareous, ambocoeliid biofacies and records a moderate shallowing. The upper shallowing cycle comprises the Butternut shales to Ashantee Member. This cycle displays a sharp base but also includes a discontinuity (forced regression surface?) at the base of the Ashantee member.

Text-fig. 2-3.1: Ashantee Member -equivalent in basincenter succession at Fayette Town quarry west of Cayuga Lake, showing strongly thicker calcareous mudstone facies sharply overlying black shale of the Butternut-equivalent upper Levanna Shale (uL). Abbreviations: BCB = Browns Creek Bed; PGB = Peppermill Gulf Bed; SCB = Salt Creek Bed. Modified and used with permission … PRI, Brett et al 2023.

Fayette Town Quarry to Stony Point State Park (rest stop/lunch)

0.0 mi	Turn Right onto Poorman Rd. heading east
0.3 mi	Turn Left onto NY-414 N
6.65 mi	Continue onto Cayuga St.
0.62 mi	Continue onto US-20 E/Auburn Rd. Continue to follow US-20 E
4.53 mi	Turn Right onto NY-90 S
16.7 mi	Turn Right onto Lake Rd.
1.5 mi	Turn Right into Long Point State Park

Lunch and rest stop at Long Point State Park. Bonus! Centerfield Member of Ludlowville Formation exposed along east shore of Cayuga Lake.

STONY POINT, CAYUGA LAKE SOUTH OF AURORA, NY
Stop Authors: Brett, Baird
Stop Leaders: Brett, Baird

Locality: Rock promontory on private land along east side of Cayuga Lake about 0.6 mi north of Long Point State Park, accessed from 2063 Lake Road south of the town of Aurora, Ledyard Township, Cayuga County, NY (42.726996, -76.711809)

Description of Units: This small rocky point on Cayuga Lake displays a gently dipping succession of the top Centerfield Member, at the base of the Ludlowville Formation. The lower Centerfield of Stony Point (Schaeffer Creek Submember) is an argillaceous lime mudstone with scattered bryozoans and brachiopods and a few larger corals, and the overlying Wheeler Gully Shale Submember. This section may just overlap with the top of Fayette shale pit and shows the transgressive phase (deepening upward) of the Ashantee-Centerfield 3rd order cycle. The contact is abrupt but gradational. The shale here contains a diversity of brachiopods including *Mediospirifer*, small *Athyris*, chonetids and *Tropidoleptus*; this fauna is very similar to that found in nearby Dean Creek on the northern edge of Aurora. However, in the Moonshine Falls section on Paines Creek, only ~ 1 mi (1.7 km) due east of Stony Point, this shale is completely missing with overlying black Ledyard Shale directly in contact with calcareous mudstone of the Schaeffer Creek Submember. The contact there is marked by a distinct phosphatic, shelly lag bed, Moonshine Falls phosphate Bed, which apparently is not exposed at Stony Point. Together, evidence suggests that the basal Ledyard rests on a submarine erosion surface with irregular topography and that Moonshine Falls lies in the axis of a broad submarine channel in which up to 3m of upper Centerfield Member shale has been removed. The Stony Point section lies on the southwestern margin of the "Moonshine channel", whereas similar Dean Creek succession lies to the northeast of this submarine erosion feature. The cause of this channeling is uncertain, but it clearly occurred during a strong deepening and associated with the period of sediment starvation during which the Moonshine Falls phosphate bed formed.

Stony Point State Park to Cascade Cuts:

0.0 mi	Exit Long Point State Park. Turn Left onto Lake Rd. heading North.
1.5 mi	Turn Left onto NY-90 N
1.57 mi	Turn Right onto Cortland Co. 42A/Sherwood Rd.
10.7 mi	Turn Left to stay on Sherwood Rd.
0.82 mi	Turn Right to onto NY-38 S.
1.35 mi	Pull over on Right for Cascade outcrop

STOP 2-4. ROUTE 38 ROADCUT, CASCADE
Stop Authors: Brett, Baird
Stop Leaders: Brett, Baird

Locality: Long roadcut along west side of N.Y. Route 38, on the west side of Owasco Lake Valley, town of Cascade, Cayuga Co., N.Y. (Moravia 7.5' Quadrangle) .

Reference: Baird (1979).

Description: This roadcut provides a good exposure of the entire upper Ludlowville section from the upper Otisco Member through to the contact with the Tichenor Limestone. Most striking at this location is the well-developed repetitive sequence of coarsening-upward cycles, each capped by thin brachiopod-bivalve coquinites. These easily accessible beds, with extensive bedding plane exposures, are ideal for collecting a nearly complete suite of Hamilton fossils. The hierarchical pattern of subcyclic units is also very well displayed, here as are the iron-stained, concretionary intervals occurring toward the bases of the major coarsening upward cycles (Text-fig. 2-4.1 and 2-4.2).

STOP 4A ROUTE 38 ROADCUT, CASCADE (LOWER)
Locality: Cuts along Rt. 38 and adjacent Mathers Road: Otisco Member and Elmwood Point Bed. Text-fig. 2-4.2

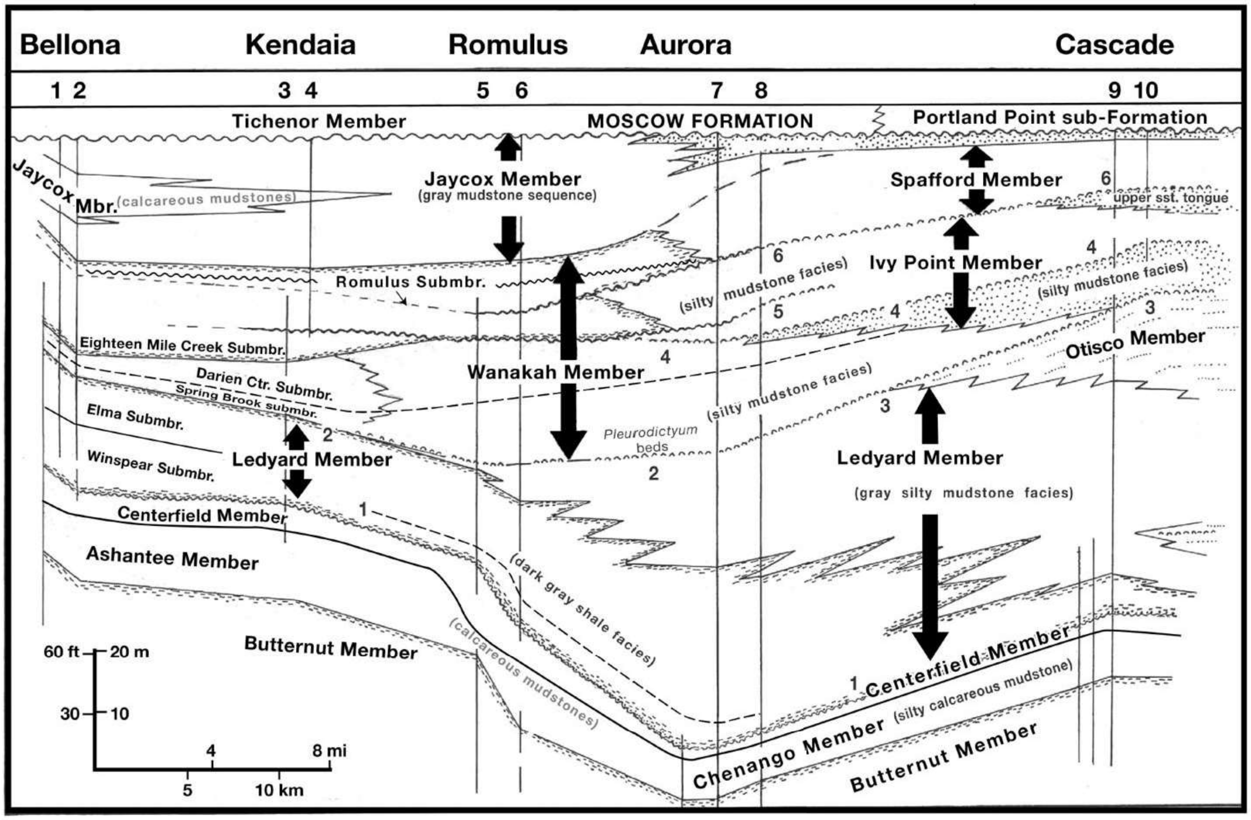
Description: The upper Ledyard Member-equivalent, here designated as upper Otisco Member, has changed noticeably in both litho- and biofacies, from dark, small brachiopod and mollusk-dominated shales of the type Ledyard section on Paines Creek just km to the west, to medium gray brachiopod-rich, silty shales here. Abundant *Mucrospirifer* and *Athyris* are associated with the bivalves *Cypricardella* and *Modiomorpha*, together with the more typical upper Ledyard nuculid bivalve-diminutive *Tropidoleptus* fauna. The Elmwood Point bed can be seen at the top of the exposure along a side road intersecting Route 38. It is represented by a silty coquinite layer, up to 10 cm thick, with an irregular base (Fig.9), which contains a moderately diverse assemblage dominated by the brachiopods *Mucrospirifer*, *Mediospirifer* and *Athyris* with associated strophomenid brachiopods and pterioid bivalves.

STOP 3B ROUTE 38 ROADCUT, CASCADE (UPPER)

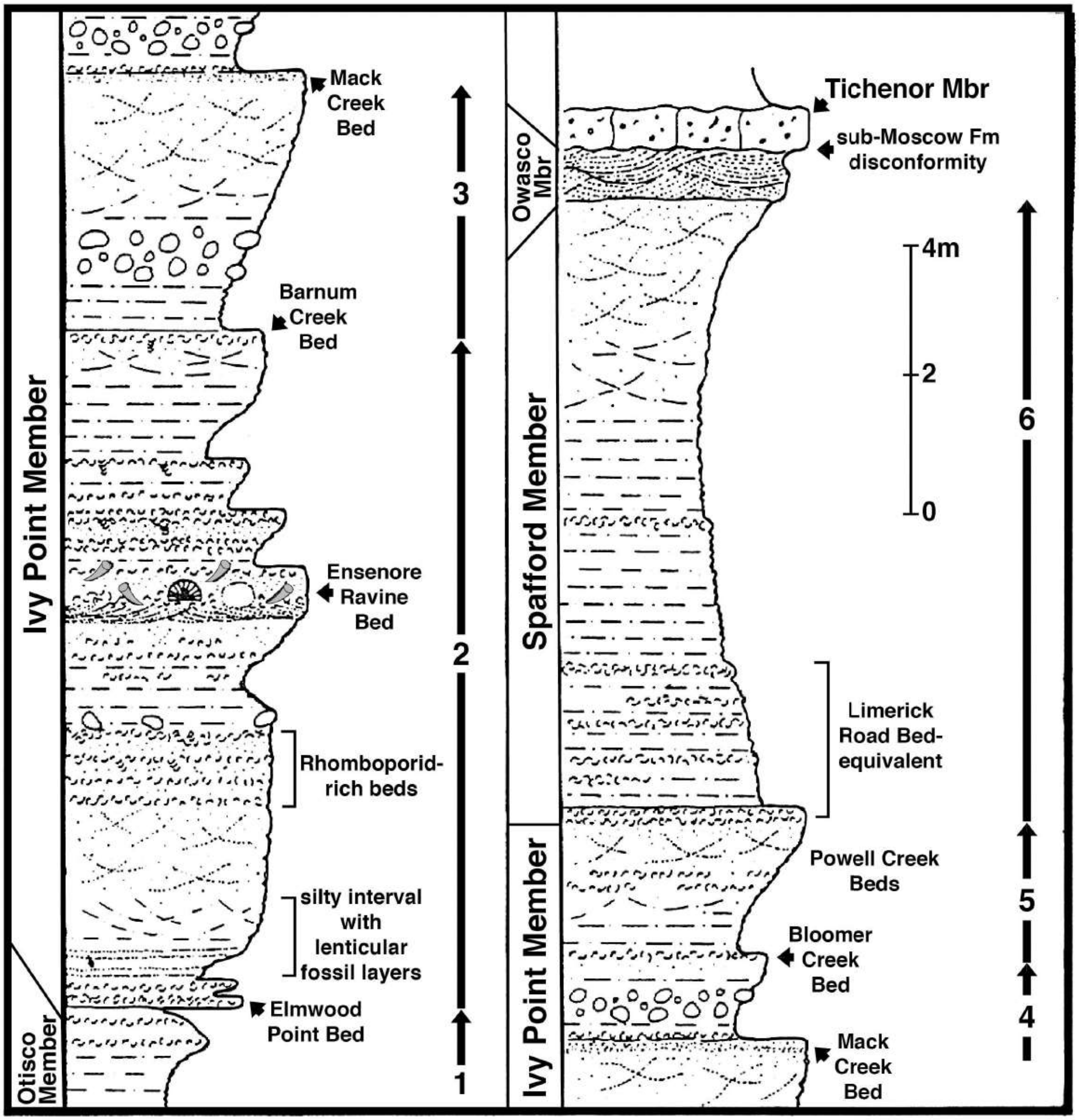
Locality: Cuts along Rt. 38 north (up hill) from junction with Mather Road: Wanakah/Ivy Point Member. Text-fig. 2-4.2

Description: This interval is dominantly muddy siltstone and is, thus, intermediate between the typical Wanakah and Ivy Point Members. Above the Elmwood Point bed the major lower cycle has both coarsened and thinned markedly to the east, being only about 7.5 meters thick at Cascade compared with over 17 meters at King Ferry (Text-fig. 2-4.1 and 2-4.2). This illustrates the observation that sediment packages thicken basinward due to the rapid dumping of finer grained sediments bypassed from more proximal, wave swept environments.

Smal scale cyclicity within the major lower cycle is more pronounced here than at either King Ferry or Portland Point. The lowest subcycle comprises 4-meters of highly bioturbated and sparsely fossiliferous silty mudstone contains several irregular, poddy fossil layers with a large brachiopod-bivalve fauna (including: *Mucrospirifer*, Medospirifer, *Athyris*, *Spinocyrtia*, Protoleptostrophia, *Tropidoleptus* , *Modiomorpha*, *Cypricardella*, *Ptychopteria,* and *Actinopteria*). Above this is a 2-meter thick subcycle which coarsens upward into massive, locally hummocky cross-stratified, coarse siltstone, indicating shallowing into normal wave base. Two prominent coraliferous horizons are present within the coarse upper unit which contain Cystiphvlloides, *Heliophyllum*, and large hemispherical colonies of *Favosites hamiltoniae*. Certain of the solitary rugose corals show evidence of corrosion and reworking. A thin (one meter) subcycle follows which is capped by a thin dense coquinite with an extremely diverse fauna. This bed is believed to be equivalent with the Ensenore bed which forms a prominent cap to the major lower cycle to the west as far as Sheldrake Creek on the west shore of Cayuga Lake; it is probably the eastern equivalent of Grabau's lower trilobite bed (Murder Creek bed) at Lake Erie. The cycles capped by the Barnum, Mack, and Bloomer Creek beds are all siltier and more prominent than at King Ferry. Unlike the major cycle below, their thicknesses show little change from King Ferry; and the upper two cycles are even somewhat thicker. Most subcycles continue to be recognizable, and the upper two concretionary intervals are well developed. Abundant pyritized burrow tubes occur below the Barnum bed in a position analogous to the concretionary interval at King Ferry. The most easily identified interval in this cut is the rust-stained concretionary horizon below the Bloomer Creek shell bed. Each of the



Text-fig. 2-4.1: Regional cross section of the Ludlowville Formation in west-central New York from Seneca Lake to Cascade near Owasco Lake. Most of the facies change can be observed in outcrops along Cayuga Lake because the northwest to southeast orientation of the lake is approximately normal to ancient facies strike. Numbered columns: 1, Wilson Creek at Slate Rock Road; 2, Kashong Glen; 3, Reeder Creek, Yale Farm Road; 4, Creek in Sampson State Park; 5, Hicks Gully; 6, Big Hollow Creek; 7, Paines Creek, Aurora; 8, King Ferry lakeshore sections; 9, Ensenore Ravine, southwest side of Owasco Lake; 10, NY Rte. 38 roadcuts, Cascade. Marker beds (marked on the stratigraphic cross section): 1, Top Centerfield, Moonshine Falls Bed; 2, Mount Vernon, formerly "*Truncalosia*," Bed; 3, Elmwood Point Bed; 4, Ensenore Ravine Bed; 5, Barnum Bed; 6, Bloomer Creek Bed. Modified and used from Brett and Baird (1986a) with permission of the New York State Geological Association and Brett et al 2023 PRI….



Text-fig. 2-4.2: Stratigraphic column for upper Ludlowville Formation at NY Rte. 38 Roadcut, Cascade, north of Moravia, Cayuga County, New York. Note a number of subtle coarsening-upward cycles from mudstone to silty mudstone or siltstone. Sedimentary succession is divided into six sedimentary successions as follows: 1, Otisco Member; 2, lower Ivy Point submember, equivalent to Spring Brook and Darien Center submember to the northwest; 3, middle Ivy Point Submember, equivalent to the lower part of the Eighteenmile Creek Submember; 4, upper Ivy Point submember, equivalent to upper part of the Eighteenmile Creek Submember; 5, Romulus Submember; 6, Spafford Member. Modified and used from Baird et al. (1986a) with permission of the New York State Geological Association and Brett et al. 2023 PRI…

Cascade Cuts to Long Hill Road:

0.0 mi	Continue downhill (Southeast) on NY-38 S
3.71 mi	Turn Right onto Warner Rd.
0.47 mi	Turn Right onto Long Hill Rd.
0.50 mi	Pull over on Right into parking area, outcrop across road on west side

STOP 2-5: LONG HILL ROADCUT, NORTH OF MORAVIA

Stop Authors: Brett, Baird, Zambito
Stop Leaders: Brett, Baird

Locality: Large roadcut on south side of Long Hill Road about 1 mile west of junction with Rt. 38, north of town of Moravia, Cayuga County, NY (Moravia 7.5' Quadrangle): Moscow Formation, Windom Shale, Tully Limestone, and Geneseo Shale.

Description: This long road cut exposes a nearly complete section of the Windom and Garrattsville members (Moscow Formation), the highest units in the Hamilton Group, together with the overlying Tully Formation and succeeding Geneseo Formation (Text-fig. 2-5.1). The Windom here shows some aspects of the more easterly equivalent, Cooperstown Member, i.e. it displays a distinct coarsening-upward, shale-siltstone cycle in the upper third, sharply overlain by fossiliferous clay shales. The lowest exposed beds are in the middle Windom shales interval (basal *Ambocoelia*-rich shales and Bay View Beds are below the level of the base of the cut). About 7 meters of middle Windom strata of the Bear Swamp Submember display several beds of fossiliferous, concretionary shales with a moderately diverse brachiopod and four meters of bivalve fauna. These beds are overlain by dark gray sheety, rusty weathering shales that contain abundant *Eumetabolotoechia multicosta* and ambocoeliids of the Fisher Gully Submember. This interval represents a fairly significant mid-Windom highstand event. Overlying these dark shales is ~9 meters consisting of pyritic fossiliferous gray mudstone with small *Amplexiphyllum* corals, *Athyris*, atrypids and *Mediospirifer*. These pass upward through ~12 meters of the Taunton Submember which is upward an increasingly silty, blocky, *Zoophycos*--churned mudstone. The top of the cycle weathers as a strong bench, reminiscent of coarsening up cycles seen in the Ludlowville Formation at the Rt. 38, Cascade roadcut. Large rugose corals and heads of *Favosites hamiltoniae* occur in the calcareous, coarse siltstones of the South Lansing Beds, the basal unit of the Garrattsville Member; this is a local reflection of a coral rich interval that forms a widespread marker in central New York and in central Pennsylvania. The highest 5 meter-thick interval of the Garrattsville Member is a highly fossiliferous, medium gray mudstone with thin layers of skeletal debris of the Spezzano Gully Submember that includes *Sulcoretepora* bryozoans, pelmatozoan debris, small rugose corals, and varied brachiopods. These beds appear to represent storm reworked skeletal pavements and, in some instances, they served as substrates for encrusting organisms, especially fistuliporoid bryozoans. One small mound in the upper part of this roadcut was illustrated by Parsons, Brett, and Miller (1988). It appears to span at least three shell beds and intervening muds.

The sharp lower contact of the Tully Limestone (mid-late Givetian, middle *varcus* subzone) on the Windom Shale is a major sequence-bounding unconformity. Regional stratigraphic correlation demonstrates that several meters of uppermost Hamilton strata (mainly dark gray shales of the upper part of the Windom) are removed at this locality. Evidently, the sub-Tully unconformity records a major episode of erosion, probably a large-scale lowstand. The basal Tully displays exichnial megaburrows that pipe Tully carbonate matrix up to 10 cms into the underlying Windom. These megaburrows formed in firm muds exposed by erosional truncation of the upper Windom sediments. Lower Tully beds are micritic limestones that have scattered brachiopods, including large ambocoeliids and *Tullypothyridina*. A cluster of these brachiopods occurs within the tube-like prods of the base of the Tully; the fossiliferous material filling these prods is interpreted to be equivalent to the DeRuyter Bed.

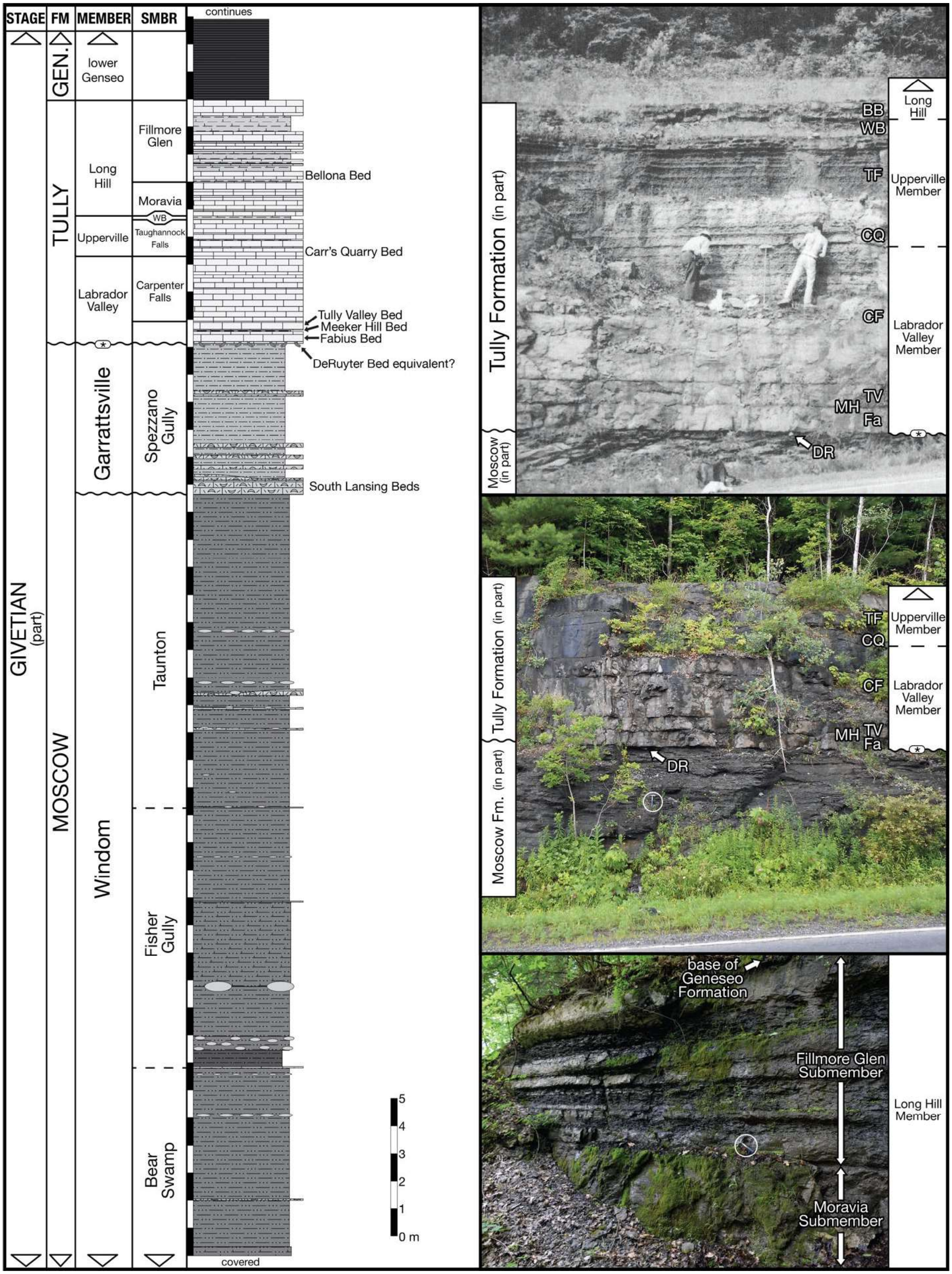
This Fabius Bed sits directly on the megaburrow prods, or the underlying Hamilton Group strata, and is overlain by the Tully Valley Bed; these beds are separated eastward by calcareous siltstone beds. *Tullypothyridina* occurs in the base of the Fabius Bed here and eastward. *Tullypothyridina* also occurs here in the middle of the overlying Carpenter Falls Submember just below the zone of discontinuity surfaces, which is the level at which *Tullypothyridina* occurs westward as the lower units disappear due to non-deposition.

Overlying units of the Tully Formation at this locality are relatively inaccessible, though these units were better exposed in the past when this section was initially studied (Fig 2-5.1; Heckel, 1973; Ziegler et al. 1976). The Carr’s Quarry Bed of the lower Taughannock Falls Submember is the uppermost unit exposed in the clean roadcut face. The upper Taughannock Falls Submember and the West Brook Shale Submember are poorly exposed as the roadcut transitions into the slope of the hillside. Around the northside of the roadcut, in the woods, the Bellona Coral Bed and an overlying zone of fistuliporid bryozoans in the Moravia Submember together are a major datum for correlation of the Tully Limestone along the outcrop belt. The exposures here of the Moravia Submember and the overlying Fillmore Glen Submember (Fig. 2-5.1) serve as the type section for the Long Hill Member of the Tully Formation. The Bellona Coral Bed marks the onset of a deepening upward succession associated with the widespread Taghanic Onlap that continues through the lower Geneseo Formation (late Givetian; IIa of Johnson et al. 1985, but see discussion in Zambito et al. 2012 and Brett et al., 2023).

The contact with the overlying Geneseo Formation is present here just below the soil horizon, and an extensive outcropping (over 30 m) of Geneseo Formation laminated black shales continues up the road to the top of the hill. Locally these shales carry a sparse low diversity fossil assemblage that includes *Leiorhynchus* and *Orbiculoidea* brachiopods, styliolines, flattened cephalopods and carbonized wood fragments. Detailed study of the Geneseo succession at Long

Hill Road has yet to identify the position of key marker beds such as the Fir Tree and Lodi Members. The Geneseo Formation strata exposed here are inferred to be late Givetian age, *hermanni* to *disparilis* Conodont zones.

(next page)
Text-fig. 2-5.1: Lithostratigraphy and annotated pictures of the Long Hill Roadcut succession. Photo at top right show the contact of the Moscow Formation and overlying Tully Formation in June 1972; photograph taken by Pierre Bultynck, Gil Klapper and Phil Heckel for scale. Photo at center right shows the same stratigraphic interval as it looked in July of 2014; white circle denotes hammer for scale. Photo at lower right shows the northern, uphill side of the main outcrop face where the Long Hill Member can be accessed as it looked in June 2020; white circle denotes hammer for scale. Abbreviations include * = unconformable contact where Shackham Brook Member has been removed (though see discussion of DeRuyter Bed equivalent in text); DR = DeRuyter equivalent? Burrow prods; Fa =Fabius Bed; MH = Meeker Hill Bed; TV = Tully Valley Bed; CF = Carpenter Falls Submember; CQ = Carr's Quarry Bed; TF = Taughannock Falls Submember; WB = West Brook Shale Submember; BB = Bellona Bed.


STAGE
FM
MEMBER
SMBR
continues
GIVETIAN (part)
GEN.
lower Genseo
TULLY
Long Hill
Fillmore Glen
Moravia
WB
Upperville
Taughannock Falls
Labrador Valley
Carpenter Falls
MOSCOW
Garrattsville
Spezzano Gully
Windom
Taunton
Fisher Gully
Bear Swamp
Bellona Bed
Carr's Quarry Bed
Tully Valley Bed
Meeker Hill Bed
Fabius Bed
DeRuyter Bed equivalent?
South Lansing Beds
covered
0 m
1
2
3
4
5
Tully Formation (in part)
Moscow (in part)
BB
WB
TF
CQ
CF
TV
MH
Fa
DR
Long Hill
Upperville Member
Labrador Valley Member
Moscow Fm. (in part)
base of Geneseo Formation
Fillmore Glen Submember
Moravia Submember
Long Hill Member

Long Hill Road to Portland Point Railroad Cut:

0.0 mi	Turn around and head South on Long Hill Rd.
1.0 mi	Continue onto Aurora Street (Long Hill Rd. turns into Aurora St.)
0.27 mi	Turn Right onto NY-38 S
3.55 mi	Turn Right onto NY-90 N
1.44 mi	Slight Left onto Creek Rd.
0.36 mi	Turn Left to stay on Creek Rd.
1.05 mi	Slight left onto Locke Rd.
1.39 mi	Turn Right to stay on Locke Rd.
1.08 mi	Turn left at 2nd cross street onto NY-34S
5.7 mi	Continue straight onto NY-35B N
0.68 mi	Turn Left onto Portland Point Rd.
1.5 mi	Park at fishing access at end of Portland Point Rd.

STOP 2-6: PORTLAND POINT; NORTHERN RAILROAD CUT

Stop Authors: Brett, Baird
Stop Leaders: Brett, Baird

Locality: Exposures on railroad cut along east-shore of Cayuga Lake between Cargill Salt Company and abandoned cement plant, 0.1 to 0.3 km north of Portland Point, town of Lansing, Tompkins Co., NY (Ludlowville 7.5' Quadrangle).

Reference: Patchen and Dugolinski (1979).

Description: This weathered railroad cut exposes about 12 m (40') of the lower Ivy Point Member and the underlying upper Otisco Shale Member of the Ludlowville Formation near the crest of the east-west trending Fir Tree Anticline (Fig. 8). These are the oldest units exposed at the axis of this fold. This section and that in the adjacent mouth of Shurger Glen afford a direct look at facies far south of the normal east-west outcrop belt some 10 to 15 miles to the north of this area. The southward Ludlowville facies change (distinct coarsening of beds with pervasive shoreward biofacies transitions) along the Cayuga Valley clearly mirrors the eastward facies changes from the Aurora-King Ferry area to the Skaneateles Valley, and we use the terminology that Smith (1935) proposed for the Ludlowville Formation in the Skaneateles Valley in describing the section at Portland Point. Text-fig. 2-6.1 and 2-6.2.

Text-fig. 2-6.1: Railroad cut at Portland Point, southeast side of Cayuga Lake, showing Portland Point subformation of the basal Moscow Formation (limestone beds in middle of outcrop) with uppermost Ludlowville Formation below.

Otisco Shale Member

About 5 m of the upper Otisco Member consists of medium gray, fossiliferous, soft silty shale. Shell beds, especially near yield abundant brachiopods, particularly *Athyris, Tropidoleptus*, *Spinocyrtia*, small bryozoans, and the rugose coral *Stereolasma*.

highly top,

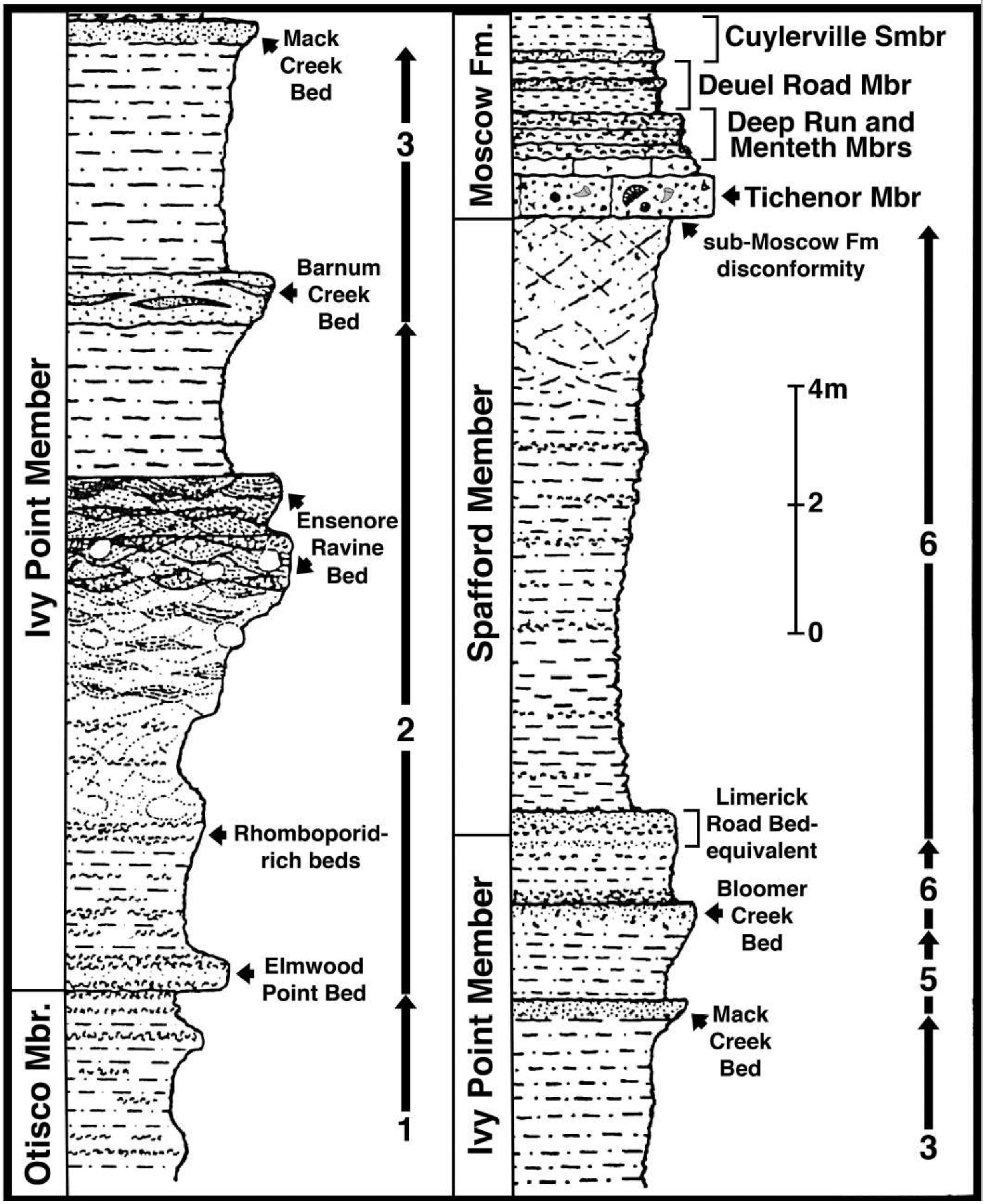
Ivy Point Siltstone Member

The upper boundary of the Otisco shales with the Ivy Point can be located at the base of a distinctive 65-70 cm (2.1 ft.)-thick silty ledge that contains abundant large brachiopods and bivalves. This unit, the Elmwood Point bed, contains large brachiopods, such as *Spinocyrtia*, and rugose corals. This bed apparently formed by sediment condensation along a paleoslope. Above the ElrmJood Point bed is an 8 meter- (26 ft.)-thick major coarsening-upward cycle which we term the lower siltstone tongue of the Ivy Point Member. It is clearly the interval equivalent of the lower Wanakah Shale (*Pleurodictyum* beds of Erie County), but it is distinctly coarser-grained. This sequence weathers with a distinctly recessed area near the base, where softer mudstone deposits overlie the Elmwood Point bed. Higher units include massive, *Zoophycos*-churned silty mudstones; joint surfaces in the intensely bioturbated siltstone display a distinctive "fretwork"-type of differential weathering, controlled to some extent by textural and/or compositional differences between sediment within-and surrounding *Zoophycos* spreiten. These heavily bioturbated mudrocks, in turn, grade upward into laminated coarse siltstone, displaying evidence of local channeling.

The upper portion of the lower Ivy Point cycle consists of hummocky cross-stratified coarse siltstone and fine sandstone. Several layers of shell coquinite, composed mainly of the brachiopods "*Allanella" tullius*, *Cupulorostrum* and minor shell hash, are visible near the top . Large (up to 0.5 m diameter) calcareous concretions occur within a prominent 1.0 m thick, massive, buff-weathering coarse siltstone bed. This coarse bed caps the major upward-coarsening (-shallowing) cycle and it is correlative with the coral-bearing siltstone bed at the top of the lower Wanakah cycle at Cascade. however, no corals have been found here, probably because this facies represents too unstable an environment. A meter-thick uppermost subcycle overlying the concretionary bed displays abundant fossil debris (*Allanella*, *Tropidoleptus*,and *Mucrospirifer*) and is probably equivalent to the Ensenore Ravine bed; this subcycle is also capped by a coarse, slightly concretionary siltstone. Finally, this unit is overlain by softer gray and sparsely fossiliferous shale which grades upward, over about two meters, into another siltstone, probably the Barnum bed-equivalent.

Above the railroad cut, along the access road to Portland Point, a higher, but somewhat similar coarsening-upward cycle marks the position of the upper siltstone tongue of the Ivy Point Member, of Smith's (1935) terminology. This upper bench is capped by about half a meter of extremely shell-rich mudstone with abundant brachiopods, which is clearly correlative with the Bloomer Creek shell bed (upper Wanakah-Blasdell submember).

(next page)
Text-fig. 2-6.2: Stratigraphic column for Ludlowville Formation at Portland Point, South Lansing, Tomkins County, New York, at the crest of Fir Tree anticline. Note distinct coarsening-upward cycles from silty mudstone to siltstone and fine-grained sandstone. Sedimentary succession is divided into six sedimentary successions as follows: **1,** Otisco Member; **2,** lower Ivy Point submember, equivalent to Spring Brook and Darien Center submembers; **3,** middle Ivy Point submember, equivalent to the lower part of the Eighteenmile Creek Submember; **4,** upper Ivy Point submember, equivalent to upper part of the Eighteenmile Creek Submember; **5,** Romulus Submember; **6,** Spafford Member. Modified and used from Baird et al. (1986a) with permission of the New York State Geological Association and Brett et al 2023 PRI…


Ivy Point Member
Otisco Mbr.
Mack Creek Bed
Barnum Creek Bed
Ensenore Ravine Bed
Rhomboporid-rich beds
Elmwood Point Bed
3
2
1
Moscow Fm.
Spafford Member
Ivy Point Member
Cuylerville Smbr
Deuel Road Mbr
Deep Run and Menteth Mbrs
Tichenor Mbr
sub-Moscow Fm disconformity
4m
2
0
Limerick Road Bed-equivalent
Bloomer Creek Bed
Mack Creek Bed
6
6
5
3

Portland Point Railroad Cut to Tully Quality Inn:

0.0 mi	Turn around and head north on Portland Point Rd.
1.5 mi	Turn Right onto NY-34B S
1.19 mi	Keep Right onto NY34B S/Peruville Rd.
10.4 mi	Turn Left onto School St.
0.94 mi	Continue onto McLean Rd.
3.5 mi	Turn Left onto Luker Rd.
1.17 mi	Turn Left onto NY-281 N/West Rd.
2.41 mi	Turn Right towards I-81.
0.53 mi	Slight Right onto I-81 N ramp
0.65 mi	Merge onto I-81 N
12.5 mi	Take Exit 14 for NY-80 toward Tully
630 ft	Turn Left onto NY-281 N
445 ft	Turn Righ onto US-11 S/NY-80 E
800 ft	Turn Left into Tully Quality Inn

END DAY 2

<u>Field Trip Day 3 – 8/3/2023</u>

Stop 1	Tully Shale Pit…right behind hotel!
Stop 2	Nedrow Rte. 11 Cuts/Creek
Stop 3	Pompey Hollow Cut
Optional Stop	Swamp Road
Stop 4	Route 20 cuts Helderberg Gp., Tristates Gp., Onondaga Fm.
Stop 5	Chestnut Street Cut
Stop 6	I-88 Cuts

<u>Stop 3-1: Tully Quality Inn Shale Pit</u>

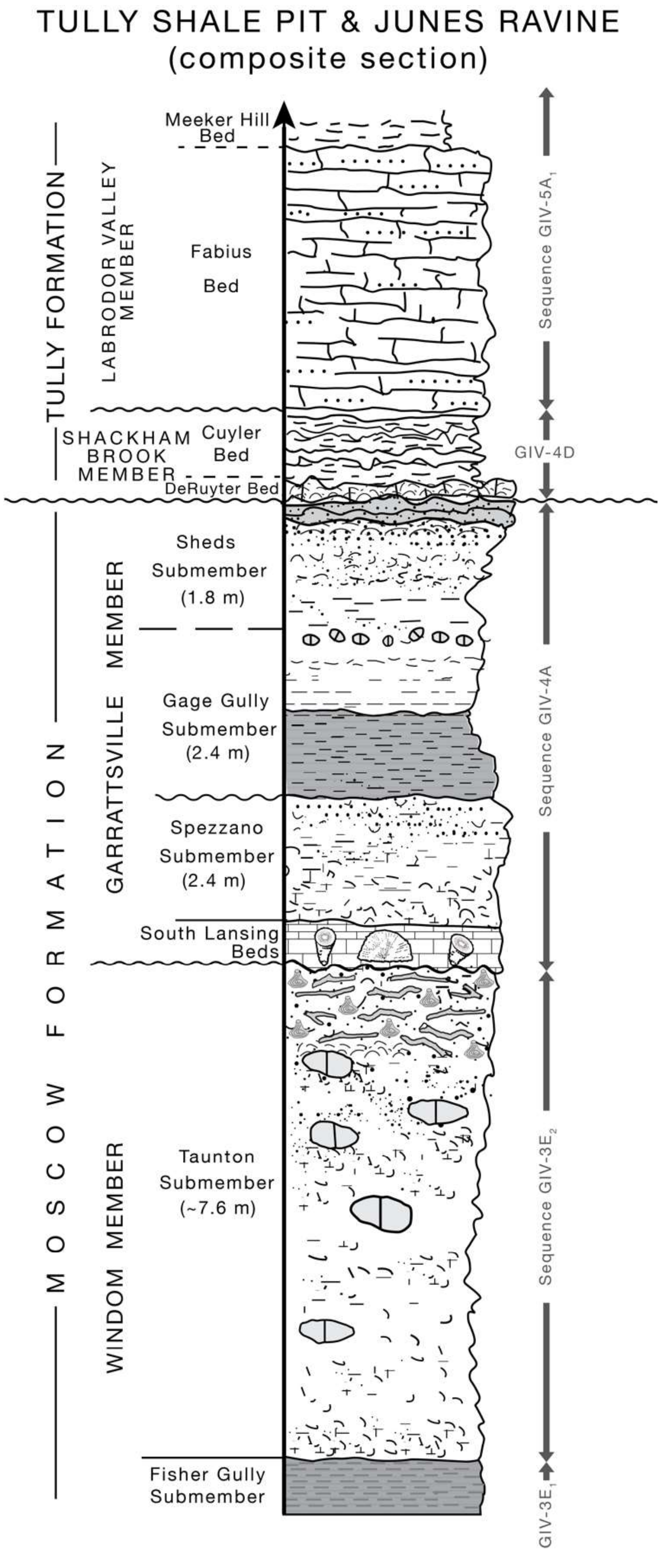
Stop Authors: Brett, Baird

Stop Leaders: Brett, Baird

Locality: Active shale pit/excavation behind the Quality Inn and extending northwest behind Kinney Drugs Pharmacy, just north of Rt. 80 (Elm Street) east of its junction with US Rte. 11and I-81, Tully, Onondaga County, NY (42.799519, -76.118897). References: Baird et al., 2003

Description: This well-known stop for professionals and amateurs alike is best known for diverse taxa of the Hamilton Fauna that occur in strata of the upper Moscow Formation Windom and Garrattsville (new) members (Text-fig. 3-1.1). Windom Member divisions exposed here include, in ascending order: the Fisher Gully submember (~2m, ~6 ft), dark fissile shale with *Paleoneilo* and *Nuculites* bivalves; the Taunton submember (~7.5m, ~25 ft), silty sandstone with abundant *Zoophycus* trace fossils and concretions centered on storm-concentrated shell debris including numerous fistuliporid bryozoa, *Spinocyrtia* and *Tropidoleptus* brachiopods, and *Cypricardella*, *Modiomorpha*, and *Actinopoteria* bivalves. Garrattsville Member divisions exposed here include, in ascending order: the Lansing Coral Bed (0.45m, 1.5 ft), coral/brachiopod-rich limestone, the Spezzano submember (1.5 m, 5 ft) calcareous siltstone with *Pseudoatrypa* brachiopods, *Stereolasma* corals, and *Zoophycus* traces; the Gage Gully submember (2.4 m, 8 ft), dark fissile shale with *Eumetabolatoechia* (‘*Leiorhynchus'*) *multicostatum*, *Emanuella praeumbona*, and diminutive *Allanella tullia* brachiopods; and the Sheds submember (1.8 m, 6 ft), coarsening-upward siltstone and fine-grained sandstone with *Mediospirifer* and *Athyris* brachiopods.

The Taunton submember is a shoaling (RST) interval. The Lansing probably marks the base of a subsequence interval. All of it (or part of it) commences a transgressive (TST) succession that continues through the Spezzano submember and into dysoxic early highstand facies of the lower Gage Gully submember. The Sheds marks the return of shoaling condition followed by another transgression recorded by the Highland Forest submember (here absent due to erosion) that is represented by dysoxic *Emanuella*-bearing strata (Baird and Brett, 2003). Diverse Hamilton taxa (too numerous to discuss here) are characteristic of the shallower facies. Not discussed in most earlier reports is the occurrence of the basal layer (DeRuyter Bed) of the Tully Formation at the top of this section. This bed is represented by a 30cm/0.3 ft thick layer of impure limestone abounding in the characteristic lower Tully strophomenid *Rhyssochonetes aurora* and rare *Tullypothyridina* brachiopods along with scattered phosphatic pebbles. This layer rests disconformably on the Sheds submember; at Junes' Ravine, 1.3 miles east -northeast of this section, the uppermost division of the Garrattsville Member (here eroded) is represented by the Highland Forest submember. At Junes' Ravine it is represented by 0.9 feet of silty, calcareous shale rich in *Emanuella*, small *Tropidoleptus*, small *Allanella*, and *Mucrospirifer*. The Cuyler Beds here contain numerous *Rhyssochonetes* and *Leptostrophia tulliensis* brachiopods while the overlying Fabius Beds consist of a resistant limestone interval with *Tullypothyridina*, *Rhyssochonetes*, *Pseudoatrypa*, *Schizophoria*, and *Emanuella* brachiopods.



Text-fig. 3-1.1: Diagramatic composite section of the upper Moscow and lower Tully formations exposed in the Tully shale pit and nearby June's Ravine.

Tully Quality Inn to Nedrow Exit cuts:

0.0 mi	Depart Tully Quality Inn. Turn Left onto US-11S/NY-80 W
810 ft	Turn Right onto US-11 N
0.61 mi	Merge onto I-81 N via ramp on Left towards Syracuse
10.5 mi	Take Exit 16 for US-11
920 ft	Turn Left onto US-11
0.45 mi	Pull over on Right by outcrop of Manlius Formation

STOP 3-2A. CUTS AT NEDROW EXIT OF I-81 AND ADJACENT RT. 11

Stop Authors: Brett, Bartholomew
Stop Leaders: Brett, Ver Straeten, Bartholomew

Location: Roadcuts on exit from I-81 onto US 11 near Quarry Road adjacent to the Onondaga Indian Nations Territory and along the east side of US 11 for 0.5 km north of the exit junction, just south of the town of Nedrow, Onondaga County, NY (South Onondaga 7.5' Quadrangle) (At the end of the exit, turn right on to Route US 11 and proceed north for approximately 0.2 miles, pulling off on the right shoulder).

Description: Exposures in the lower (northern) portion to the cut along Route 11 display the Lower Devonian (Lochkovian) Jamesville and overlying Pools Brook members of the Manlius Formation. The Jamesville Member, locally, contains an interval, approximately 2.5 thick, of packed, large stromatoporoids (Text-fig. 3-2.1). Most of the stromatoporoid coenostea appear to be in growth position in a slightly nodular skeletal wackestone matrix. A few have been tumbled and overturned. Small favositid and syringoporid corals are also present in this interval.

Text-fig. 3-2.1: Stromatoporoids in the Jamesville Member of the Manlius Formation along Rte. 11.

The Jamesville Member is overlain by pale gray-weathering, very finely and evenly laminated micrites of the Pools Brook Member. Thin intervals of disrupted laminae, desiccation cracks, and intraclasts occur within this interval. Finally, at the very top, immediately below the Onondaga limestone unconformity, is a thin interval of small stomatoporoids, representing recurrence of deeper water conditions.

The Manlius here represents peritidal to shallow subtidal, lagoonal facies. Detailed correlations of Rickard (1964) inferred that this portion of the Manlius is laterally equivalent to the upper Manlius Deansboro Member, a crinoidal pack- and grainstone in east-central New York and, perhaps, with the Kalkberg interval of the Hudson Valley. These units are of Early Devonian (Lochkovian) age.

The Pools-Brook Member of the Manlius is sharply and unconformably overlain by the Onondaga limestone (Edgecliff Member). Strikingly, some 3m of greenish-gray sandy shales and red sandstones found just 1 mile (1.6 km) to the north along I-81 are absent here indicating irregularity on the sub-Edgecliff unconformity (Text-fig. 3-2.2).

Text-fig. 3-2.2: Manlius/Onondaga formation contact at large-scale, composite unconformity. Most of the Helderberg Group and all of the Tristates Group is missing at this unconformity.

The basal 10 cm of the Edgecliff, however, does contain large, dark gray phosphatized sandstone masses, apparently derived as erosional remnants from the latter unit, which had been removed prior to deposition of the Onondaga very locally. The Edgecliff Member is well-displayed here and contains a series of yellowish-gray chert nodules above its base, as well as large coral heads. It displays a sharp contact with the greenish-gray, shaly beds of the Nedrow member that are exposed at the corner formed by the exit lane and Route 11. The black beds, prominent on I- 81 cuts immediately to the north, and in most other localities in west-central New York, are represented only by gray shales and thin limestones. The type section of the Nedrow Member is immediately to the south in the old Onondaga Indian Nations quarry. Nedrow is, therefore, rather atypical at its type locality.

The Nedrow is overlain by highly cherty micritic limestones (sparse, skeletal wackestones and burrowed lime mudstones) of the Moorehouse Member.

Return to vehicles and reverse directions on Route 11 by proceeding forward to the next available crossover. (Route 11 has a median strip between lanes adjacent to the outcrop). Proceed back underneath the I-81 bridge, turn right, and then immediately left onto a small side road (Kennedy Road Spur that connects US11/I-81 entrance road with Kennedy Road. Park vehicles and examine small creek in ditch section immediately below.

STOP 3-2B. SENTINEL HILL CREEK, KENNEDY ROAD

Location: Section of upper Onondaga and Union Springs formations in a small NW flowing creek that lies between Kennedy Road and US Rte 11 at junction of entrance ramp for northbound I-81, immediately north of Kennedy Road Spur, Nedrow (town of Lafayette), Onondaga County, NY (42.957792, -76.136191). Upstream of the culvert and immediately east of Kennedy Road at its junction with Kennedy Spur the same creek exposes a dipping section of the basal Oatka Creek Formation at 42.957764, -76.135032.

Description: This is a small stream ("Sentinel Hill Creek"), flows through a ditched section of the uppermost Onondaga (Seneca Member) and overlying Union Springs Formation (mid-late Eifelian; probably uppermost *Pol. costatus costatus* to *T. australis* Zone though conodont control is poor). Note that the beds of the upper Seneca are relatively tabular, exposed along the ditch for some distance. However, near the south end of the outcrop, the beds abruptly turn to a near-vertical orientation (Text-figs. 3-2.3 and 3-2.4). The overlying Union Springs black shale is extensively deformed and folded into a series of small, tight anticlines and synclines, at least one of which contains a pinch of the Seneca member. The black shales have been extensively slickensided and heavily sheared in this outcrop.

Across Kennedy Road, upstream on the same creek exposes a dipping section of the upper Union Springs black shale, including horizons of ellipsoidal (concretions?) and the overlying Chestnut Street Bed (Hurley Member) and Cherry Valley limestone (see Ver Straeten et al., 2023), which form a waterfalls in the creek with beds dipping at approximately 45 degrees to the northwest, but not nearly as deformed as in the adjacent ditch section. These beds are of late

Eifelian age as the conodonts of the *Tortodus kockelianus* -eiflius Zone have been obtained from both units at various localities (see Klapper, 1981). Large goniatites (*Agoniatites expansus* (Vanuxem)) have been obtained from the upper bed of the Cherry Valley at this location. Note that Cherry Valley and Chestnut Street bed are amalgamated at this location. Return to vehicles, reverse direction, and proceed onto the entrance ramp for Route 81 South.

Text-fig. 3-2.3: Close-up of tightly-folded lower Union Springs Formation in Sentinel Hill Creek.

Text-fig. 3-2.4: Vertically-bedded lowermost Union Springs Formation in Sentinel Hill Creek.

Nedrow Exit Cuts to Pompey Hollow:

0.0 mi	Head west on Kennedy Spur Rd. toward US-11
330 ft	Turn Left onto US-11 S (Possible rest stop just west of US-11/US-20 jct. at McD's)
5.0 mi	Turn Left onto US-20 E
10.8 mi	Pull over on Right at top of long roadcut. Be careful to not block field access lane

STOP 3-3. MOTTVILLE AND DELPHI STATION MEMBERS, POMPEY HOLLOW SECTION

Stop Authors: Brett, Baird

Stop Leaders: Brett, Bartholomew

Locality: This is a roadcut that has served as an important section for viewing lower Hamilton Group facies and collecting fossils. Recent widening of the road has both enlarged and lengthened the section. Moreover, exposure of the fresh rock face to the elements has served to loosen and release an enormous number of fossils.

Stratigraphic Units: The Mottville Member is now exposed in its entirety as well as ~1.0 meter of underlying rock assignable to the Cardiff Member and Morrisville Station (new) members of the Oatka Creek Formation. Above the 8 meter-thick Mottville succession is a 23-meter section including almost the entire succession of the Delphi Station Member and the base of the Pompey Member. This latter interval includes 7 meters assignable to the Cole Hill cycle within the lower part of the Delphi Station Member and 10 meters comprising most of the main Delphi Station cycle succession within the middle and upper parts of the Delphi Station Member (Text-fig. 3-3.1).

Description: The base of the section is an interval of gray sparsely fossiliferous shale assigned to the Cardiff Member. It is abruptly overlain by a thin (15 cm) shell-rich calcareous mudstone bed, the Mason Hill Bed (new) recently assigned to base of the Morrisville Station Member (Brett et al., 2023; Chapter 1). The Mason Hill Bed yields abundant brachiopods including *Mediospirifer* as well as associated bryozoan debris and exuviae of the trilobite *Dipleura.* The Morrisville Station is regarded as the uppermost, regressive cycle of the major Oatka Creek depositional sequence; at this location the interval is relatively thin (3.7m) but it balloons slightly to the east near Morrisville (Stop 2). These beds were formerly assigned to the lowest Mottville Member (Grasso, 1986) but locally appear to be overlain and/or truncated at an erosional contact of the basal Mottville.

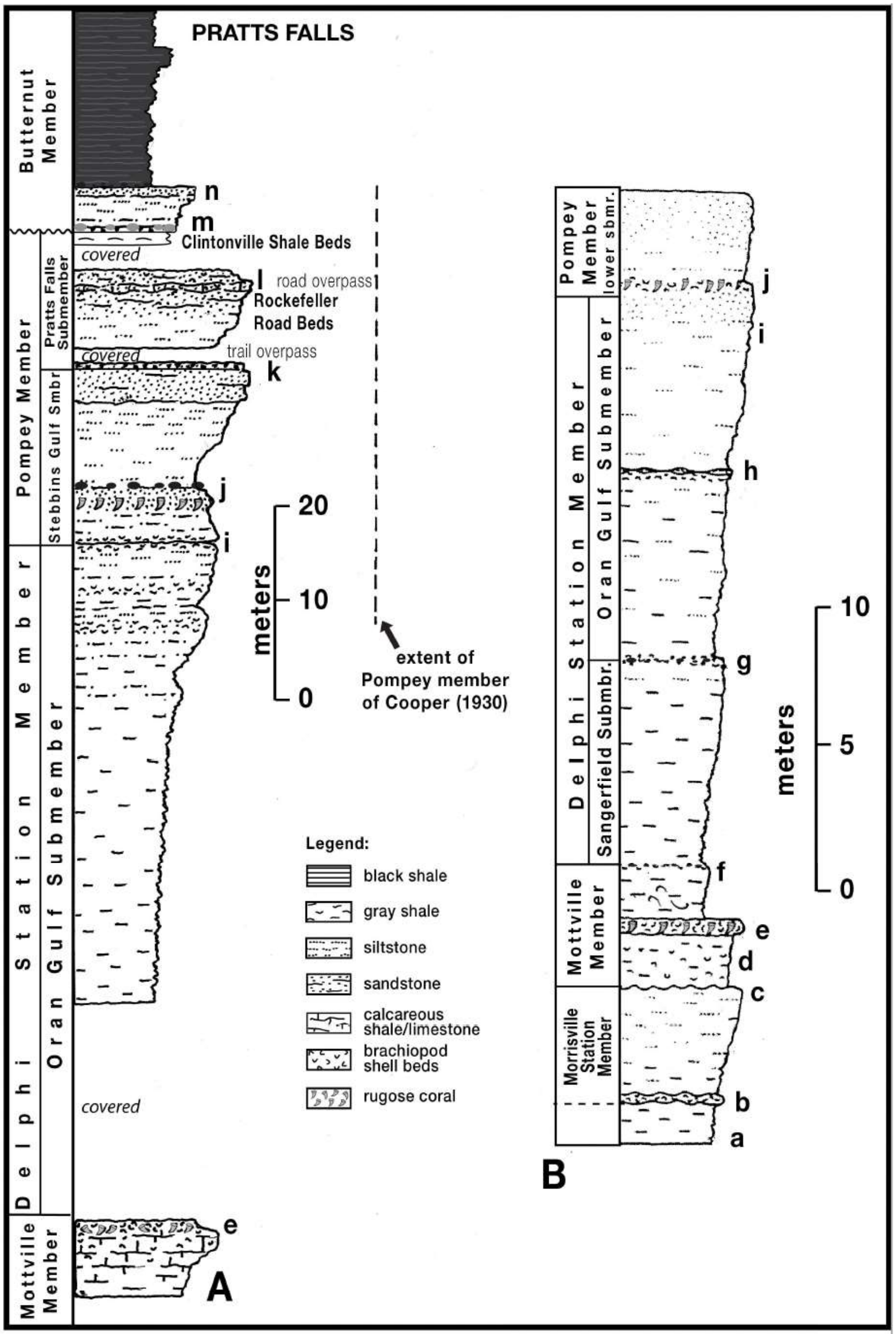
The Mottville Member, at this locality, is marked by two distinct horizons that mark the bases of its two submembers. The base is marked by a prominent parting about 3.8 meters vaguely coarsening upward succession above the Mason Hill Bed. Normally this basal contact of the Mottville is marked by a crinoidal limestone, but here this unit is absent or lenticular. In other sections within the Marcellus, South Onondaga and Jamesville 7.5' quadrangles, the Cedarvale Bed is a 0.2-0.3m packstone-grainstone encrinite layer; comparable to the higher Stone Mill (base Ludlowville) and Tichenor (base Moscow) limestones. As such, overlies a sequence boundary regionally and represents a basal transgressive lag; at this section the sequence boundary unconformity is probably represented by the reentrant below the *Tropidoleptus* interval.

Between the parting and the Case Hill Bed is 3.8 m mudstone rich in *Tropidoleptus, Nucleospira* and *Mediospirifer*, typical of the lower or Rattlesnake Gulf Submember of the Mottville. Above the Case Hill Bed is 2 m of softer mudstone rich in *Ambocoelia* and small mollusks, which we now assign to the upper or Hogsback Road Submember of the Mottville.

The 0.3 meter-thick shell-coral-rich bed in the upper Mottville is clearly the Case Hill Coral Bed of Grasso (1986) and it corresponds to the base of the Hogsback Road Submember of Brett et al. (2023). The Case Hill Coral Bed yields large rugose and tabulate corals as well as diverse brachiopods. The upward change from the unit into soft, *Ambocoelia-rich* shale marks a significant deepening event within a larger transgressive systems tract succession above the sequence boundary reentrant. The top of the Mottville is typically marked by a bedding plane covered by small brachiopods as well as gastropods and orthoconic cephalopods displaying black calcite preservation. This maximum flooding surface, unfortunately, is poorly exposed in this section.

Above the Mottville interval is a 7-meter-thick interval of gray shale and gray silty shale that is bounded at the top by a shell bed yielding abundant phosphatic nodules associated with numerous *Athyris cora* and other fossils. This shell bed marks a discontinuity that can be traced westward into the Levanna Member as far as Cayuga Lake. Between Cayuga Lake and the Tully Valley, this layer is typically characterized by reworked concretions encrusted by auloporid corals in association with molluscan debris. East of the Tully Valley the reworked concretions are replaced by small phosphatic pebbles and a somewhat more diverse associated biota. We believe that this shell-phosphate layer projects to the top of the Cole Hill Sandstone bed near Sangerfield. Between the top of the Mottville and the top-Cole Hill cycle shell-phosphate bed is an interval of shale yielding abundant clams, snails and cephalopods displaying black calcite preservation. Gastropods, including *Bembexia* and *Palaeozygopleura,* as well as nuculoid bivalves and cephalopods, are typically preserved three-dimensionally.

Above the shell-phosphate bed is a 16-meter-thick interval of silty shale grading upward to fine sandstone at the upper (west) end of the outcrop. This part of the section corresponds to the upper Delphi Station upward-coarsening cycle. The uppermost beds in this interval are considerably coarser than equivalent strata at Pratts Falls suggesting a trend to greater facies proximality towards the southeast. The coarse beds at the top of the section contain abundant bivalves and occasional large brachiopods such as *Spinocyrtia.* Three meters below the top of this section is a band of medium-size corals (*Enallophrentis broweri* Oliver, 1992) that is also observed at nearby sections; this bed likely correlates to the Papermill Bed-Roanoke Bed interval at the base of the Pompey member in western New York.



Text-fig. 3-3.1: Diagramatic sections for: A) the west Pompey Hollow section along Rte. 20. B) Pratts Falls near Pompey. Modified from Baird et al. (2000).

Pompey Hollow to Swamp Road Quarry:

0.0 mi	Continue East (downhill) on US-20 E
4.0 mi	Turn Left to stay on US-20 E
900 ft	Turn Right to stay on US-20 E
11.25 mi	Turn Left onto Cedar St.
0.5 mi	Slight Right onto Swamp Rd.
1.81 mi	Swamp Rd. Quarry on right

OPTIONAL STOP: SWAMP ROAD CUT, MORRISVILLE

Stop Authors: Brett, Baird
Stop Leaders: Brett

Locality: Large roadcut along the east side of Swamp Road (Cedar Street), below "The Ledges", about 3.5 km north of center of Morrisville, Madison County, NY (Morrisville 7.5' Quadrangle).

Stratigraphic Units: Middle Devonian (earliest Givetian?) Pecksport Member (Oatka Creek or upper Marcellus Formation), Mottville Siltstone (Skaneateles Formation).

Description: This is a classic fossil locality generally, but erroneously referred to as the Solsville Siltstone. The large cut has been discussed in detail by Newman et al. (1992). The upper Pecksport displays a coarsening and shallowing upward cycle that passes upward into the siltstones of the Mottville Member of the Skaneateles Formation.

Lowest beds are dark gray sparsely fossiliferous shales with a *Eumetabolotoechia* fauna. This pass upward into *Ambocoelia* and *Mucrospirifer*-bearing mudstones. The middle beds in the outcrop are dark gray silty mudstones with small concretions. They are especially noted as a source of beautifully preserved (black calcite) molluscan fossils. These include a variety of nuculid bivalves, *Ptychopteria*, *Gosseletia*, and the gastropods *Palaeozygopleura* (*Loxonema*) and *Bembexia*; small specimens of *Spinocyrtia* are also moderates common in silty mudstones high in the outcrop. Uppermost beds are buff-weathering siltstones with abundant brachiopod and bivalve molds.

These beds are the lateral equivalent of the uppermost Oatka Creek black shales of western New York, but they are much thicker, siltier and display a dysaerobic to lower aerobic biofacies. This outcrop provides an overview of the one the lowest typical coarsening upward cycles that are so typical of the Hamilton Group in central New York. Progradation of siliciclastics may have been triggered by an allocyclic fall of actual sea-level. The cause of exquisite preservation of molluscs in the lower Hamilton and rare if ever in the upper remains enigmatic. CEB-GCB

Swamp Road Quarry to Cherry Valley:

0.0 mi	Turn around and head South on Swamp Rd.
1.81 mi	Continue onto Cedar St.
0.5 mi	Turn left onto US-20 E
50 mi	Pull over on Right just past old railroad overpass/entrance ramp

STOP 3-4a. U.S. ROUTE 20, CHERRY VALLEY – Helderberg Group

Stop Authors: Ebert

Stop Leaders: Ebert

Locality: Roadcuts east of abandoned railroad bridge, on the north and south sides of U.S. Rte. 20, north of Cherry Valley, Otsego Co. (Sprout Brook 7.5' Quadrangle).

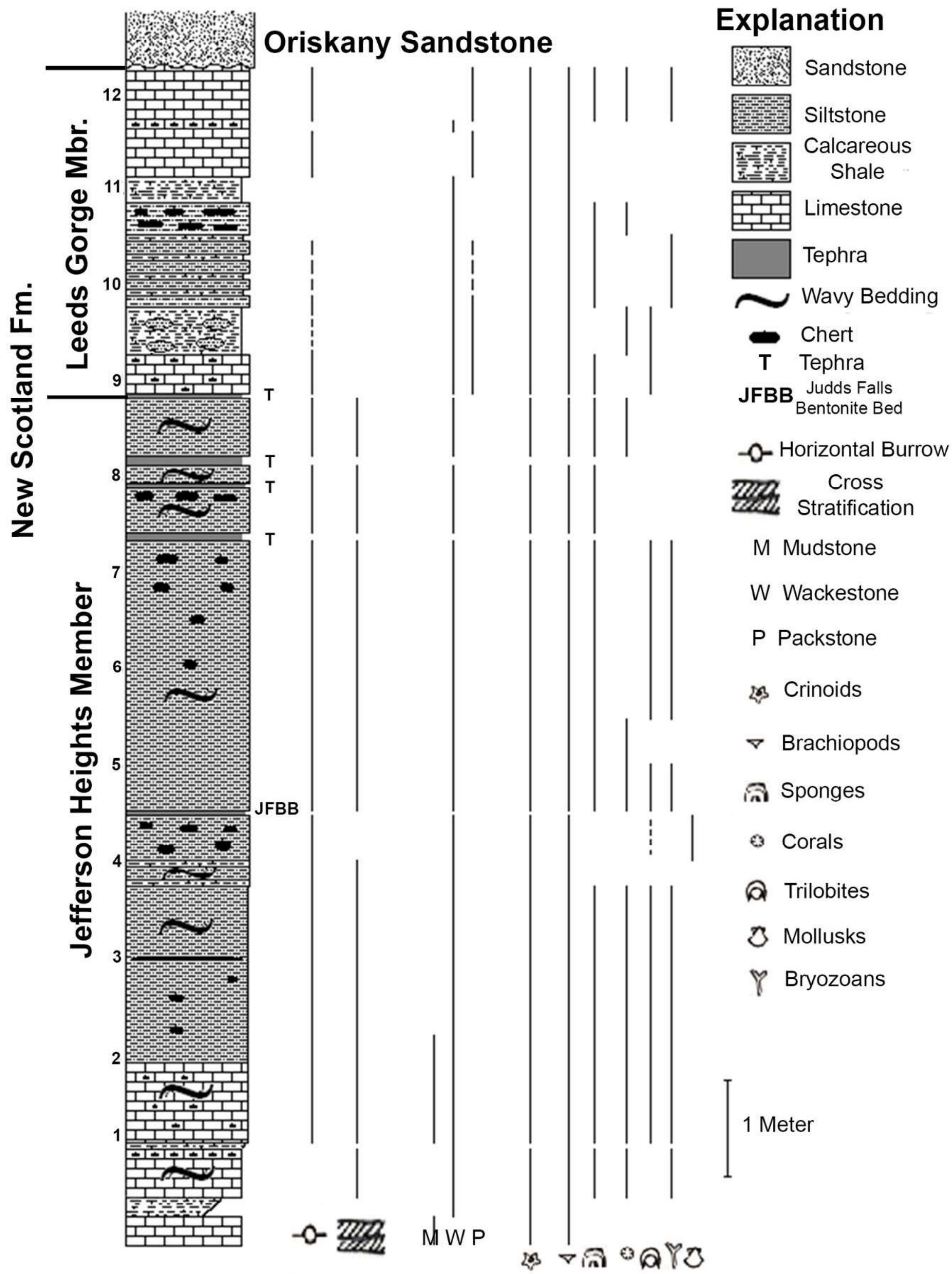
HELDERBERG GROUP - NEW SCOTLAND FORMATION, THE JUDDS FALLS BENTONITE BED AND THE ORISKANY SANDSTONE

The long road cut on the south side of Rte. 20, east of NY Rte. 166 exposes a nearly continuous section of the mid-Lochkovian New Scotland Formation (formerly regarded as Kalkberg Formation) near the middle of the Helderberg Group. The upper portions of the New Scotland Formation are also well exposed on the north side of the highway.

The base of the New Scotland is covered at the west end of this road cut, west of the railroad overpass. The section begins in the siliceous Jefferson Heights Member of the New Scotland Formation (Text-fig. 3-4a.1). An impure tephra bed is present at the base of a low cliff near the bottom of the exposed section. The Jefferson Heights Member is quartz- and chert-rich, with insoluble residues from some samples exceeding 70%. Siltstone is the predominant lithology. The member is characterized by undulose bedding. Remnant cross lamination and form concordant cross lamination in some beds suggests that the undulations are symmetrical ripples with internal stratification obscured by bioturbation.

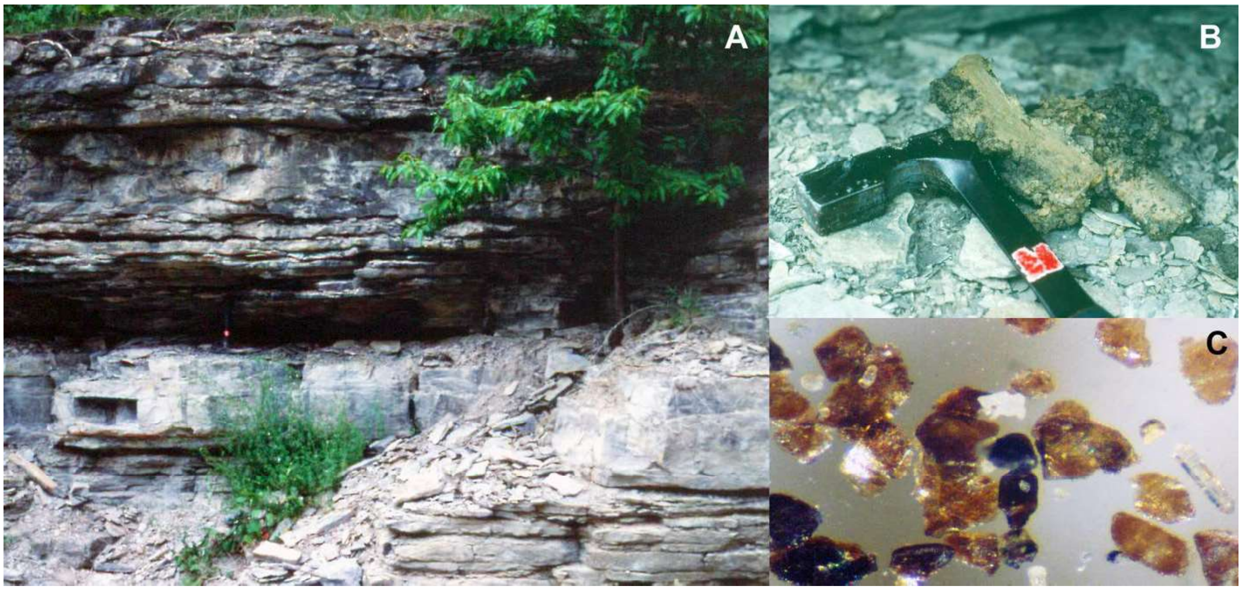
Text-fig. 3-4a.1: Siltstones of the Jefferson Heights Member of the New Scotland Formation. Undulatory bedding reflects broad ripples, some with remnant cross lamination.

Five distinct tephra beds occur in the Jefferson Heights and the overlying Leeds Gorge members of the New Scotland Formation at Cherry Valley (Text-fig. 3-4a.2). These include the tephra originally reported by Rickard (1962), which is exposed one to two meters above the base of the outcrop on each side of the road. Several publications refer to this tephra as the “Kalkberg Bentonite,” a clear misnomer owing to the fact that this tephra is within the New Scotland Formation, which overlies the Kalkberg Formation. McAdams et al. (2017) clarified this by using the original name coined by Conkin and Conkin (1984) – the Judds Falls Bentonite Bed. Zircon microphenocrysts (Text-fig. 3-4a.3) from this tephra have been dated radiometrically by Tucker et al. (1998; 417.6 Ma +/-1 Ma), Husson et al. (2016; 417.68 Ma +/- 0.21/0.27/0.52 Ma) and McAdams et al. (2017; 417.61 Ma +/- 0.12 Ma). These radiometric ages have been used to approximate the Silurian-Devonian boundary on several recent geologic time scales. However, it must be noted that this tephra bed is several tens of meters above the probable location of the Silurian-Devonian Boundary in New York and that beds adjacent to the tephra bed have yielded a fauna of middle Lochkovian chitinozoans.



Text-fig. 3-4a.2: Measured Section for outcrop on US 20, Cherry Valley. Column shows positions of confirmed tephra beds and illustrates the lithologic difference between the Jefferson Heights and Leeds Gorge members of the New Scotland Formation.

On the north side of Rte. 20, four additional tephra beds are present, termed the Bald Hill Cluster by Ver Straeten et al. (2005). Smith et al. 1988 suggested that two of these layers, along with the Judds Falls Bentonite Bed were correlative with the Bald Hill K-bentonites described by them in Pennsylvania. However, Hanson (1995) was unable to confirm this correlation using the chemistry of glass inclusions within microphenocrysts.



Text-fig. 3-4a.3: A) Outcrop of Judds Falls Bentonite Bed; B) Field sample of tephra bed weathered to sticky clay; C) Microphenocrysts of biotite and one zircon (clear prism on right, below C) from the Judds Falls Bentonite Bed. U-Pb ages from zircons such as shown in C have been used in calibration of the Devonian Time Scale.

The Leeds Gorge Member of the New Scotland Formation overlies the Jefferson Heights Member. The Leeds Gorge comprises decimeter-scale limestone beds with interbedded shales of similar thickness (Text-fig. 3-4a.4). The limier beds are skeletal wackestones to grainstones with a diverse benthic fauna. Many of the limestone beds are substantially chertified, especially in the upper part of the member in western outcrops such as this Rte. 20 exposure near Cherry Valley. Brachiopods are the dominant taxa. Small globose sponges are common, particularly in the upper beds.

Text-fig. 3-4a.4: Contact between the Jefferson Heights Member and the overlying Leeds Gorge Member of the New Scotland Formation. Note interbedding of skeletal limestones with limey shales and prominent chert bed near top of exposure.

The regionally angular Wallbridge Unconformity of Sloss (1963) truncates the New Scotland Formation, having removed the upper portion of the New Scotland and the overlying Becraft, Alsen and Port Ewen formations, which are present in the Hudson Valley (Stops 3 and 4). The Oriskany Sandstone, a quartz arenite, rests on the Wallbridge unconformity. Quartz grains in the Oriskany are well-rounded and of medium to coarse sand size. The unit is approximately 80 cm thick at Cherry Valley. A few large brachiopods occur in the upper part of the bed. The juxtaposition of the Oriskany Sandstone over the Wallbridge Unconformity marks the initiation of a major transgression.

STOP 3-4b: Tristates Group and Onondaga Formation
Stop Authors: Ver Straeten
Stop Leaders: Ver Straeten

Additional main references for these U.S. Route 20 cuts north of Cherry Valley, Otsego County, include Ver Straeten et al. (2005, 2012)

Wallbridge Unconformity

The Wallbridge Unconformity is one of six major unconformities in North America and beyond. They lie at the at the base of six Cambrian to recent Sloss Supersquences (Sloss, 1963). The Wallbridge Unconformity and its correlative conformity marks the boundary between

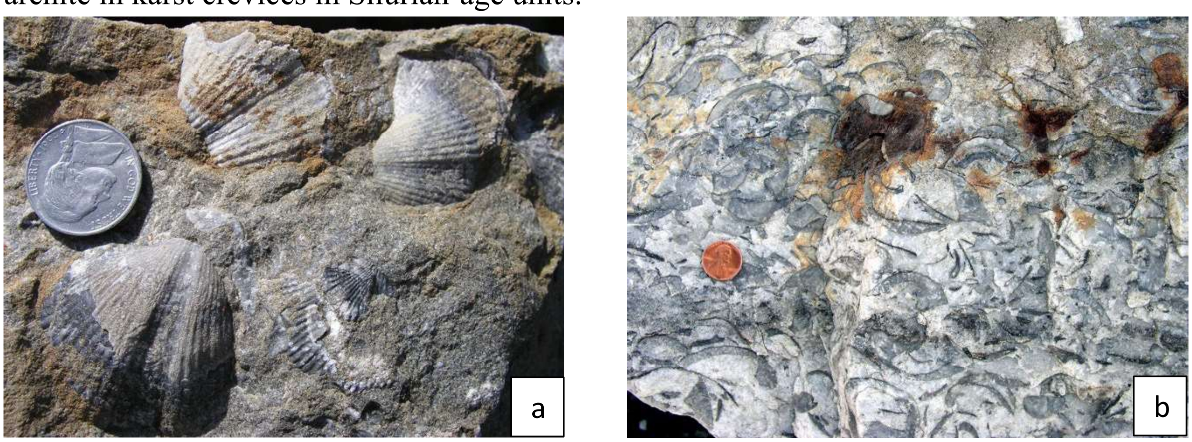
Sloss's Tippecanoe and Kaskaskia supersequences. In the Appalachian Basin it underlies the Oriskany Sandstone and correlative strata. In shallower areas of North America, including parts of New York, multiple unconformities coalesce into an unconformity of greater duration of missing time (e.g., Stop 1-1, Neid Road quarry; Brett et al., 2000)

The transition between the Tippecanoe and Kaskaskia supersequences is conformable in deeper parts of Appalachian Basin. This includes the vicinity of Port Jervis, southeastern New York, area where New York, New Jersey and Pennsylvania meet. In that area, deposition is interpreted to have been continuous through Lochkovian upper Helderberg Group strata through the apparent Pragian Port Ewen, and Pragian Port Jervis and Glenerie formations.

In past, the position of the Wallbridge Unconformity was misplaced by some in the Appalachian Basin as being above the Oriskany Sandstone. That unconformity, as currently covered here along U.S. Route 20, is a flooding unconformity, related to a major episode of transgression (lower part, Devonian Sequence Ib1/Ems-1), with a period of sediment starvation, indicated in part by widespread concentration if authigenic deposits of phosphate, iron and glauconite.

Oriskany Sandstone

The Oriskany Sandstone along the northern Devonian outcrop belt in New York (Text-fig. 3-4b.1a,b) is a formation-level unit. The term Oriskany is now utilized for Pragian-age sandstone facies around most of the Appalachian Basin. It is a supermature quartz arenite, ~correlative in New York and Appalachian Basin with the cherty Glenerie Limestone (Text-fig. 3-4b.2), and milky quartz pebble conglomerate of the Connelly Conglomerate, and correlative strata around the basin. The Glenerie and Connelly formations extend downward to older levels than the thin Oriskany Sandstone southward down the Hudson Valley outcrop belt and to Port Jervis, as the Wallbridge Unconformity gradually closes in to a conformable boundary. The thin Oriskany seen here and at Day 4, Stop 1b extends along the outcrop belt from the Hudson Valley westward, and pinches out in central New York, where it only appears as infillings of quartz arenite in karst crevices in Silurian-age units.



Text-fig. 3-4b.1: a) Large spiriferid brachiopods from the Oriskany Sandstone in Knox, NY. b) Masses of large brachiopod shells in the Oriskany Sandstone from Seneca Stone Quarry, NY.

Text-fig. 3-4b.2: Glenerie Formation at type section along Rte. 9W north of Kingston, NY.

The thin Oriskany Formation west from the Hudson Valley in New York is interpreted to be Pragian – however, there is no clear biostratigraphic or other data to recognize the Pragian-Emsian boundary (currently under revision internationally) in New York and the Appalachian Basin. Certainly, in deeper portions of the Appalachian Basin, such as the Port Jervis, NY area, thick successions of Oriskany-Glenerie-Connelly and correlative strata are Pragian. However, along the shallow Oriskany outcrop belt from Albany County west, the Pragian-Emsian boundary, as is being revised toward the traditional position, may occur within the Wallbridge Unconformity or, on the other hand, extend up into lower parts of the overlying Esopus Formation and correlative strata in the basin.

Faunally, one of the most characteristic features of the Oriskany Sandstone and correlatives is the classic “Big Shell Community” of Boucot and Johnson (1967; Text-figs. 3-4b.1a,b), characterized by a diverse assemblage of sometimes large-size, thick-shelled brachiopods and other taxa. Brett and Baird (1995) assigned the Oriskany-Glenerie-Connelly fauna to its own Ecological-Evolutionary Oriskany faunal subunit.

At Cherry Valley, the Oriskany Sandstone is only 1 m-thick, and directly overlies the Wallbridge Unconformity,. The thickness here is typical of the formation from western Albany County in the east to central New York, where local patches of Oriskany appear discontinuously along the outcrop belt until the unit is absent through the rest of the New York outcrop belt to the west. One of the thickest Oriskany successions across this region is at a quarry near its type section near Oriskany Falls, Oneida County (Text-fig. 3-4b.3).

Text-fig. 4-4b.3: Succession at Oriskany Falls Quarry, NY. Strata include Manlius (Ma), Oriskany (Or), Schoharie (Sch), and Onondaga (On) formations.

Esopus Formation

The Esopus Formation represents the initial synorogenic deposited in New York during the Acadian Orogeny. Esopus strata are non-calcareous, predominantly mudrocks, with minor fine-grained sandstones. Rehmer (1976) indicated that silt to sand fractions are rich in quartz, indicating that sediments were not derived from the Acadian orogen. Shelly fossils are rare in the Esopus, though strata are commonly bioturbated by soft-bodied fauna. Smaller brachiopods (e.g., *Atlanticocoelia*) are present in a few intervals. notably in the lowermost beds at Cherry Valley

As noted above, the position of the Pragian-Emsian stage boundary is unknown in New York and the Appalachian basin. In the early 1990s, Ver Straeten found a small number of conodonts from the Oriskany-Esopus contact here north of Cherry Valley, following separation of clays and coarser/denser particles from an altered airfall volcanic tephra lying on the Oriskany-Esopus contact. This should be collected again and analyzed - though strong faunal provincialism in the Emsian Stage, including with conodonts, make this difficult. The Esopus fauna is distinct from that of the underlying Oriskany and overlying Schoharie Formation. Therefore, Brett and Baird (1995) and Brett et al. (1996, 2009) assigned the Esopus Fauna to its own Ecological-Evolutionary faunal subunit, distinctly different from the underlying Oriskany fauna, and from the overlying Schoharie fauna.

Three member-level units are recognized in the Esopus Formation (Ver Straeten, 1996, 2007; Ver Straeten and Brett, 2006). These are termed the Spawn Hollow, Quarry Hill, and Wiltwyck members, low to high. Ver Straeten (2007, 2009), along with the underlying thin Oriskany Formation along the outcrop belt, reported these strata to represent three separate 3rd order depositional sequences (Devonian Sequences Ib_1, Ib_2 and Ib_3; or alternatively Sequences Ems-1, Ems-2 and Ems-3). These have been correlated all along the Appalachian Basin outcrop belt from eastern New York to southwestern Virginia (Ver Straeten, 2007, 2009, 2023b). The Spawn Hollow Member, directly above the Oriskany here along U.S. Route 20, is characterized by a lower interval of interbedded cherts, shales, and 15 altered volcanic tephras, succeeded by a dark shale, and a Ib_1 sequence-capping siltstone to fine sandstone. The Spawn Hollow Member here near Cherry Valley is 4.4 m-thick. The overlying Quarry Hill Member of Sequence Ib_2 generally consists of a relatively thick succession of silty mudstones with a capping fine-grained sandstone, as below. However, here near Cherry Valley, most of the Quarry Hill Member is eroded out below a sub-Schoharie Formation unconformity – only 1.7 m of soft, clay-rich shale remains. In addition, the entire Wiltwyck Member (Sequence Ib_3) is totally absent here under the sub-Schoharie unconformity. The unconformity is very obvious on the outcrop; a prominent ledge of the siltstones to sandstones of the Carlisle Center Member, Schoharie Formation, sticks out over the Quarry Hill Member shales. Prominent, detailed trace fossils are present on the underside of the Carlisle Center Member.

Two further interesting points to the Esopus in the Cherry Valley region: 1) the Quarry Hill Member is very clay-dominated shale here, unlike the silty, bioturbated mudstones seen to the east (e.g., Stop 4.7; Text-fig. 3-4b.4) and 2) the entire Esopus is eroded out below the sub-Schoharie Formation unconformity approximately 28 km (18 mi) west-northwest of this locality along U.S. Route 20 north of Cherry Valley.

Text-fig. 3-4b.4: Dark shales of middle member of Esopus Formation (Quarry Hill Member) below overhang at base of Carlisle Center Member of the Schoharie Formation.

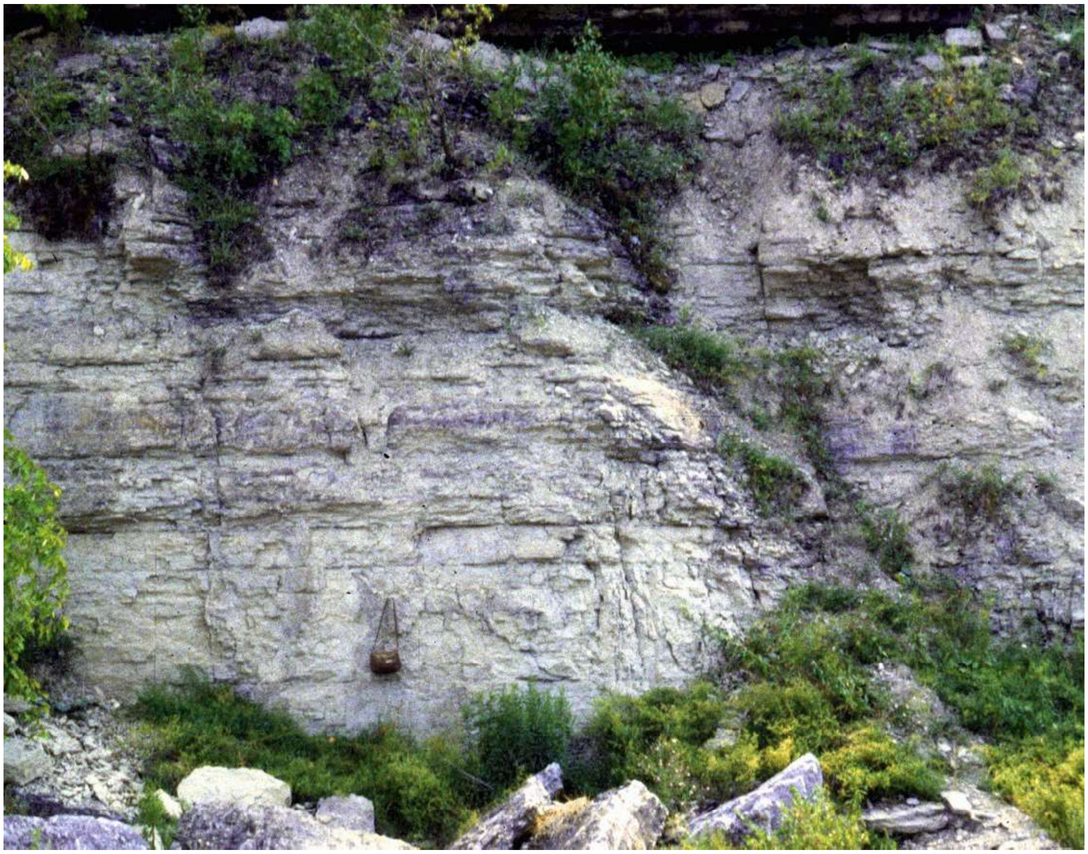
As noted above, the lower part of the Spawn Hollow Member, lower part of the Esopus Formation, is characterized in eastern New York by 8-15 altered airfall volcanic tephras, sometimes termed K-bentonites or otherwise, which reflect their diagenetic history, and not their geologic origin – hence the use of "tephra" beds for these layers. This cluster of multiple tephras, at its type section here along Route 20, is termed the Sprout Brook tephras (Ver Straeten, 1996, 2004a, b);

Here at Cherry Valley altered tephra beds occur in the lower 3.6 m of the Spawn Hollow Member (Text-fig. 3-4b.5), where they overlie quartz arenites of the Oriskany Formation. The section is largely covered at this time. As is typical of the Sprout Brook Tephras, they appear as a series of thin (<1 to 14 cm-thick), clay to claystone layers interbedded with shales and thin siliceous siltstone to chert beds characteristic of the lower portion of the Spawn Hollow Member. Tucker et al. (1997) dated two layers from this site; they yielded an age of 408.3 +/- 1.9 Ma. This date overlaps with numerous plutonic and volcanic rocks in northern New England, especially in Maine (Ver Straeten, 1996, 2004b, 2010; Ver Straeten et al., 2020).

Text-fig. 3-4b.5: Spawn Hollow Member, including Sprout Brook Tephra Beds, of the Esopus Formation along US-Rte. 20, south side north of Cherry Valley. Jacob Staff rests on top of Oriskany Sandstone. Conondonts reported from lowest tephra layer resting on contact.

Schoharie Formation

The Schoharie Formation represents upper Emsian strata of the Dalejan substage. Generally, the formation consists of calcareous finer-grained siliciclastics to mixed carbonate-siliciclastic lithologies, in a basic "cleaning upward" succession between siliciclastics of the underlying Esopus and limestones of the overlying Onondaga Formation. However, west of the Helderberg Hills to the east of us and westward into central New York, the Schoharie is dominated by siltstones to sandstones assigned to the Carlisle Center Member (Text-fig. 4-4b.6). Authigenic phosphate, glauconite and/or locally hematite is common in the member. In addition, passing into central New York, presence/absence of the member becomes spotty before disappearing in the central Finger Lakes area.



Text-fig. 3-4b.6: Carlisle Center Member of Schoharie Formation along US-Rte. 20, south side, north of Cherry Valley. Note hanging camera bag for scale.

The Schoharie Formation features a more abundant and diverse fauna, and represents another Ecological-Evolutionary (Schoharie) subunit (Brett and Baird, 1995; Brett et al., 1996, 2009). A thin unit at the top of the formation in eastern Schoharie to Albany County features abundant cephalopods and corals (refs, including Flower).

Schoharie Formation strata comprise two upper Emsian sequences, Depositional Sequences Ib4 and 1b5 (=Ems-4 and Ems-5). In the Hudson Valley, these two sequences are distinguished as the Gumaer Island Member and the Aquetuck and Saugerties members, respectively. Both sequences occur with the often-glauconitic siltstone- to sandstone-dominated facies of the Carlisle Center Member, including at this stop.

As noted with the Esopus Formation above, the two divisions of the Schoharie Formation, and their respective depositional sequences can be recognized down through the Appalachian Basin Lower Devonian outcrop belt, even to Wytheville in southwest Virginia (Ver Straeten, 2007, 2023).

Onondaga Formation

The Onondaga Formation (Text-fig. 3-4b.7) represents Middle Devonian limestone strata, deposited during a quiescent stage in the Acadian Orogeny. Little siliciclastic sediment was transported from the orogen into New York at that time. Similar limestone-dominated facies of the same age were widely deposited across the eastern U.S., and even in southern Quebec, Canada (Boucot and Johnson, 1967). The formation is divided into four members in New York (Oliver 1954, 1956a; Ver Straeten and Brett, 2006); these units, along with numerous distinct marker beds, are correlated at least into the central Appalachian Basin in Virginia and West Virginia (Needmore Formation, Selinsgrove Member and upper Huntersville Formation to at least Frost, West Virginia). The members and many of the marker unit are also distinct in the Columbus Limestone in central Ohio (Ver Straeten, 2007, 2023)

Text-fig. 3-4b.7: Strata of lower Edgecliff Member, lowest member of the Onondaga Formation, exposed on west side of valley along US-Rte. 20, north side, north of Cherry Valley, NY.

In New York, limestone lithologies range from coarse crinoidal grainstones and reef/reef debris facies to packstones, wackestones, and carbonate mudstones/micrite, with minor shales in deeper areas. In some areas, chert is common to very abundant in parts of the formation; in other areas is uncommon. Across New York State at that time, shallower marine facies occur in western and eastern areas of the state; a deeper water tongue extends into the central Finger Lakes area of central New York. In addition, Onondaga facies indicate a gradual deepening southward through the easternmost outcrop belt in the Hudson River Valley, a trend that may continue southwest of there to the Port Jervis area, when the boundaries of New York, New Jersey and Pennsylvania meet.

The position of the Emsian-Eifelian boundary remains unclear in the Onondaga Limestone. Klapper and Oliver (1995) reported Eifelian conodonts in the base of the second member (Nedrow Member); however, no diagnostic biostratigraphic taxa have been found in the Edgecliff Member in New York and correlative strata in the lower submember of the Selinsgrove Member of the Needmore Formation in central Pennsylvania. Ver Straeten does have collections of various biostratigraphically important Emsian and Eifelian taxa at the New York State Museum, from throughout the Appalachian Basin. Biostratigraphic analyses of these samples are welcomed.

Multiple distinct marker beds permit broad correlation of Onondaga-correlative strata across the Appalachian Basin. These include key sequence stratigraphic intervals; numerous altered airfall volcanic tephras, including the Tioga A-G beds in upper Onondaga strata along with additional tephras, in New York and correlative strata in the eastern U.S. More detailed reports on the Devonian airfall volcanic tephras in New York and the eastern states include Ver Straeten (1996, 2004a,b, 2010) and Ver Straeten et al. (2005, 2012, and 2020).

The Onondaga Fauna, rich and diverse, represents another Ecological-Evolutionary subunit (Brett and Baird, 1995; Brett et al., 1996, 2009). Widely across New York State, basal Onondaga strata are characterized by abundant corals, which in eastern and western New York, including the Cherry Valley area, build up into biohermal reef mounds (Oliver,1956b; Wolosz and Paquette, 1988; Wolosz, 1992; see further references in Ver Straeten et al., 2023; also, Day 4, Stop 3). Even in deeper parts of the basin in southern New York and northern Pennsylvania, pinnacle reefs formed associated with the orogenward migration of paired feature consisting of a narrow bulge-like uplift and a cratonward small sub-basin low around the lowstand at the base of Onondaga time (Ver Straeten and Brett, 2000). A similar pair of features migrated orogenward during deposition of the Tully Limestone in mid-Givetian time (Baird et al., 2023).

Cherry Valley to Chestnut Street:

0.0 mi	Continue east on US-20 E
2.0 mi	Turn Right onto Otsego Co. Rd. 34A
100 ft	Turn Right onto Chestnut Street
175 ft	Pull over on Right across from Cherry Valley Member outcrop

Day 3, Stop 5: Chestnut Street Roadcut
Stop Authors: Ver Straeten
Stop Leaders: Ver Straeten, Bartholomew

Location: Chestnut Street, just south of junction with US Rte. 20

Units: Marcellus subgroup: Union Springs and Oatka Creek formations (Bakoven Mbr.; Hurley, Cherry Valley, and East Berne members)

Description: This stop examines upper Eifelian strata of the Marcellus subgroup of Ver Straeten et al. (1994) and Ver Straeten and Brett (2006). Further information on the Marcellus subgroup is available in Ver Straeten et al. (2023).

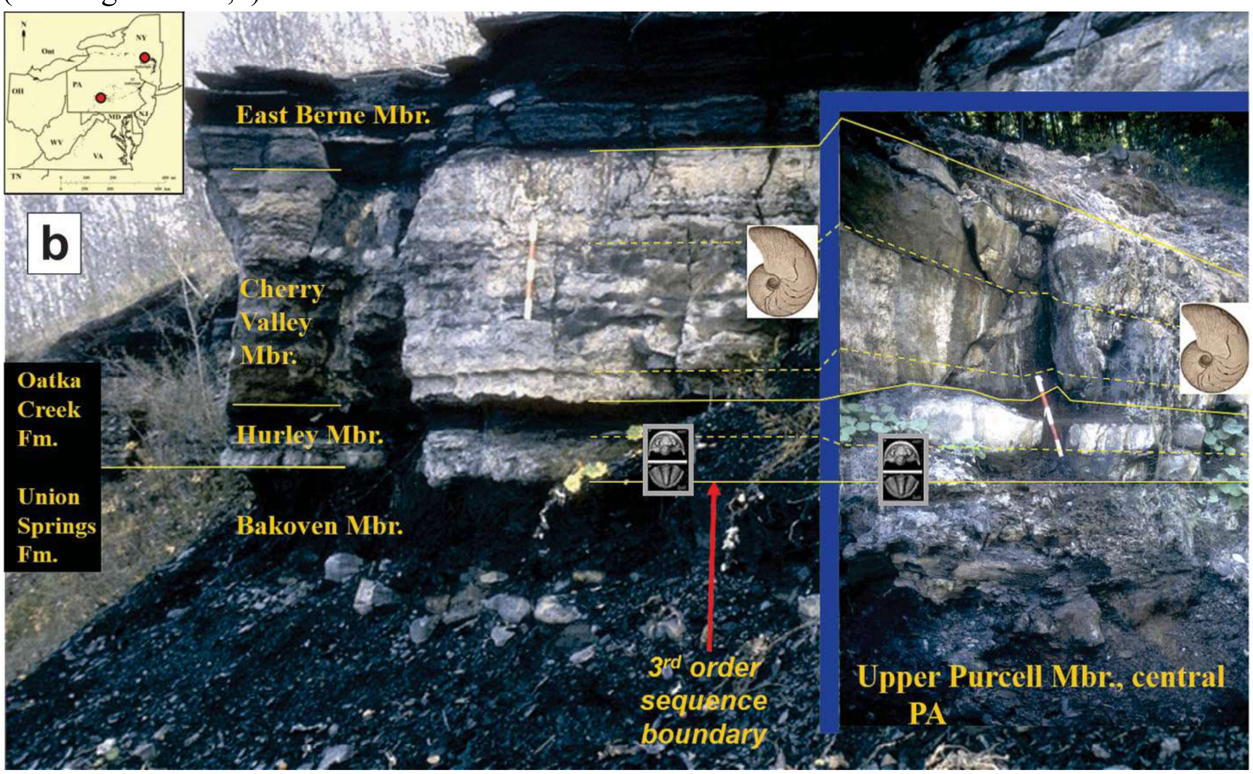
Four members of the Marcellus subgroup are seen in the Chestnut Street roadcut, low to high: 1) Bakoven Member of the Union Springs Formation; and 2) Hurley, Cherry Valley and East Berne members of the Oatka Creek Formation (Text-fig. 3-5.1)

Text-fig. 3-5.1: Upper Union Springs and lower Oatka Creek formations exposed along south side of Chestnut Street, northeast of Cherry Valley, NY.

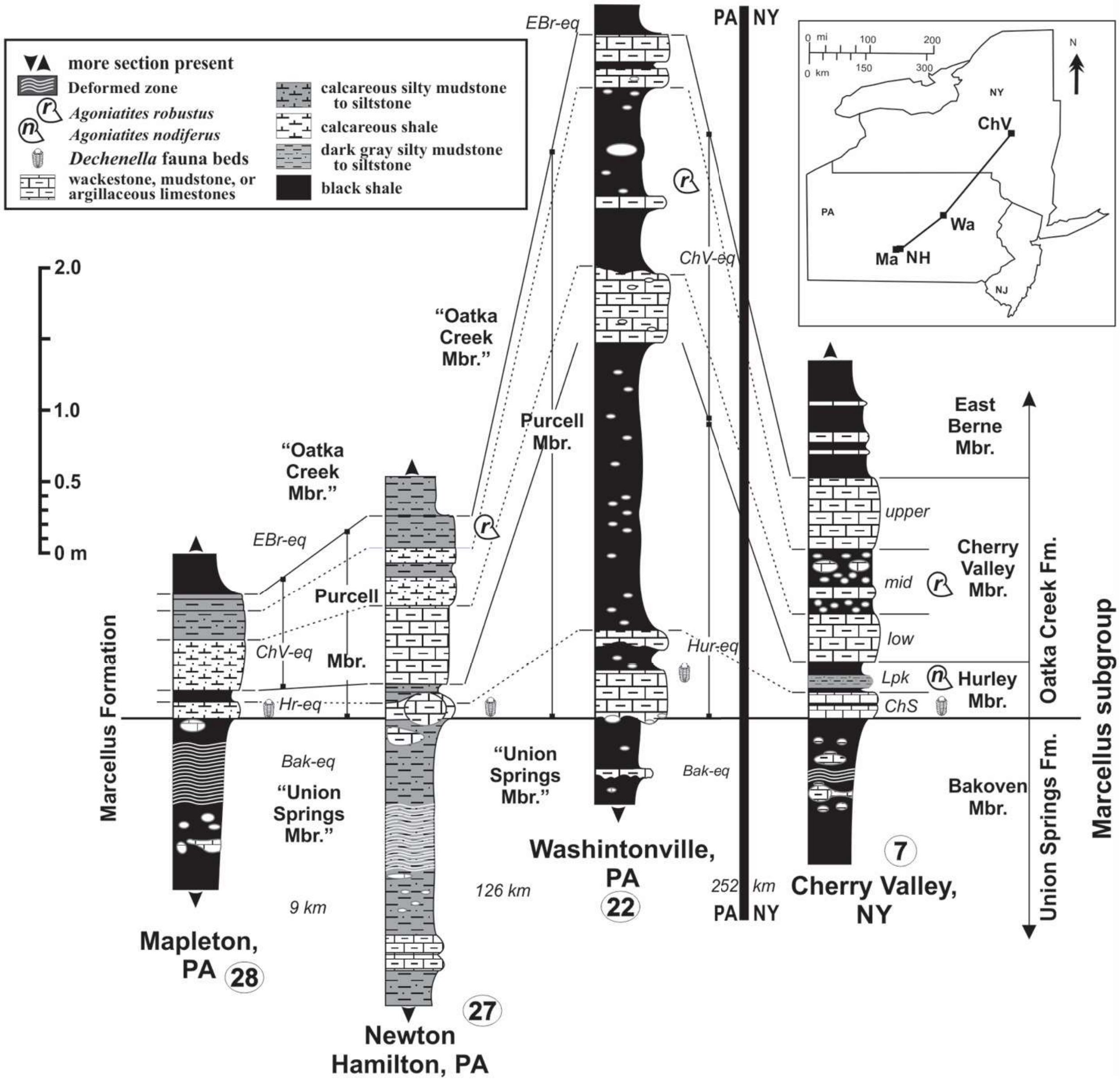
The Bakoven Member is one of two members of the Union Springs Formation in New York. It represents chiefly black to dark gray shale to mudstone facies, with generally minor concretionary limestones of generally chemical origin, which in central New York coalesce into laterally ~continuous layers. Faunally, much of the Bakoven is barren. Faunas are largely restricted to pelagic/nektonic forms, or those adapted to dysoxic facies. A band of concretions approximately 1.0 m below the base of the Cherry Valley Member at this locality commonly feature the goniatite *Cabrieroceras plebeiforme*.

From the Helderberg Plateau east of here, in western Albany County, Bakoven facies represent the entire Union Springs Formation. South of the Helderbergs, however, upper Bakoven strata transition, from the top downward, to buff-colored calcareous mudstones to siltstones, capped by a thick, resistant, falls-forming sandstone. These strata are assigned to the Stony Hollow Member. We will see these strata at Kingston, in the Hudson Valley, on Day 5, Stop X.

The Hurley and Cherry Valley members of the overlying Oatka Creek Formation seen here represent widely occurring, thin mid-Marcellus carbonates. In more basinward sections in the Appalachian Basin, time-correlative strata appear similar to their development at Chestnut Street (Text-figs. 3-5.2a,b).



Text-fig. 3-5.2a: Mid-Marcellus strata along Chestnut Street (left) and Newton Hamilton Railroad cut, central PA (right). Goniatite photo is *Agoniatites expansus* in the Cherry Valley and correlative strata and trilobite photo is *Dechenella haldemanni* from the Hurley Member and correlative strata.



Text-fig. 3-5.2b: Fence diagram of mid-Marcellus strata in distal portions of the basin, from northeast to southwest.

The Hurley Member at Chestnut Street is represented by a thin limestone consisting of two beds, and an overlying dark shale with a thin siltstone bed with *Agoniatites nodiferus.* These two subdivisions are termed Chestnut Street and Lincoln Park submembers, low to high. The fauna of Chestnut Street limestone ledge includes proetid trilobites (*Dechenella haldemanni*), various brachiopods, small rugose corals (*Guerichiphyllum echoense*), and the small crinoid *Haplocrinites*, along with other benthic taxa indicative of fully oxic facies.

The Hurley Member represents lowstand to initial transgressive systems tracts at the base of Depositional Sequence Ie/Eif-Giv. Throughout the Appalachian Basin, Hurley and correlative strata represent shallower marine litho- and biofacies than the overlying Cherry Valley Member and its correlatives (with one exception in western New York, where there is syn-sedimentary movement on a normal fault).

West of Cherry Valley, the upper Lincoln Park shale pinches out, and two decimeter-scale Hurley Member limestone beds, capped by hardgrounds, are “welded” to the base of the Cherry Valley. East to southeast of Cherry Valley, the Hurley Member thickens. East of the Schoharie Valley, as it passes into the Mount Marion Formation, where it occurs as several thin limestones interbedded with dark siliciclastic mudstones. However, southward through the Hudson Valley, the Hurley and Cherry Valley members transition into a time-correlative siliciclastic lithosome. The Hurley Member, in its type section near Kingston, Ulster County (Day 5, Stops **X-X** consists of 8.3 m of siliciclastic mudstones to fine sandstones. Multiple thin shell beds with a “Stony Hollow Fauna” occur in the lower part of the member there; a pair of sandstone beds in the upper part of the unit feature *Agoniatites nodiferus*, as here at Cherry Valley.

Cherry Valley Member

The Cherry Valley Member, in its type area near Cherry Valley, is typical of its development west of the Helderbergs of western Albany County. It forms a single, meter-scale ledge, which commonly forms small waterfalls in creeks. Three informal submember divisions are recognized: 1) a lower, thin limestone unit; 2) a middle, slightly recessive calcareous mudstone with scattered, decimeter-scale relatively purer limestone concretions; and 3) a thicker, upper limestone unit. Faunas of the Cherry Valley in the type area include smaller, more dysoxic faunas than the underlying Hurley Member, along with straight nautiloid and goniatite cephalopods, the latter including *Agoniatites expansus*. A very fine large block of the Cherry Valley Member, from the New York State Museum Paleontology Collection, is on exhibit at the Museum.

West of the Schoharie Valley in eastern New York, including here near Cherry Valley, is assigned to the Oatka Creek Formation, a unit characterized by a greater percent of basinward, shale/siliciclastic mudstone dominated facies. East of the Schoharie Valley, the unit is assigned to the coeval Mount Marion Formation, which overall represents shallow marine facies. Southward along it’s Hudson Valley outcrop belt, the Cherry Valley Member transitions from its carbonate lithosome to a coeval siliciclastic-dominated lithosome.

East Berne Member.

The East Berne Member consists of predominantly dark gray mudstones to black shales. At its type section near East Berne, thin siltstone and sandstone layers occur scattered through the section, but building up to a capping sandstone body. This sandstone package at the top of the unit greatly expands in thickness in Hannacrois Ravine 7.7 km (4.8 mi) to the east-southeast. East Berne faunas in the Helderbergs and Hudson Valley generally consist of dysoxic and pelagic faunas of leiorhynchid brachiopods, small nuculid and other bivalves, and straight nautiloid and goniatite cephalopods. The first appearance of the Hamilton fauna occurs in a marker bed, the Dave Elliott (DE) Bed (Ver Straeten, 1994). In central Greene County, at

Earlton, the Dave Elliott Bed fauna includes typical Hamilton Group medium to large Hamilton brachiopods and corals amongst other forms. However, to the north and south, the fauna grades down to small forms including small chonetid brachiopods. Beyond eastern New York, Ver Straeten et al. (2011) suggested the Dave Elliot Bed may be present at Seneca Stone Quarry, between the large Cayuga and Seneca Lakes in central New York, underlying another key marker bed, the Halihan Hill (HH) Bed, which overlies the capping sandstone of the East Berne Member, at the base of the Otsego Member. In the Helderbergs and northern Ulster County, this bed is a coral-rich unit, approximately a meter thick. The HH Bed is absent through northernmost Ulster and Greene counties, at an erosional unconformity formed at a the base of a second of three 4th order depositional sequences within Devonian Sequence Ie/Eif-Giv. The DE and HH beds have not been located in the bank above the Chestnut Street locality here, but one of these beds, we're not sure which, has been located in a small quarry along Hoyer Road north of Route 20 west of the deep valley north of the Hamlet of Cherry Valley.

CHESTNUT STREET TO I-88 CUTS:

0.0 mi	Turn around and head north on Chestnut Street
175 ft	Turn Left toward US-20 E
100 ft	Turn Right onto US-20 E
3.88 mi	Turn Right onto NY-10 S
11.6 mi	Turn Right onto Warnerville Cutoff
0.85 mi	Turn Right onto NY-10 S/NY-7 W
0.26 mi	Turn Left onto Hite Rd. toward I-88
0.3 mi	Turn Left onto I-88 E toward Albany
8.5 mi	Pull over on Right shoulder along large Helderberg Group outcrop

STOP 6: ROAD CUTS ON I-88 NEAR COBLESKILL AND SCHOHARIE:
Stop Authors: Ebert
Stop Leaders: Ebert

Location: Long outcrop along the eastbound lane of I-88 east of Exit 23 at Schoharie.

Stratigraphic units: Brayman Shale, Cobleskill and Chrysler members of the Rondout Formation, Thacher, Green Vedder and Dayville members of the Manlius Formation, Coeymans Formation, Kalkberg Formation (subunit d), Jefferson Heights and Leeds Gorge members of the New Scotland Formation, Old Stone Fort Member and b-2 facies of the Becraft Formation

Description: Construction of Interstate 88 in the 1980s produced several large outcrops in strata of the Helderberg and Tristates groups. We will drive past an outcrop that exposes the upper portion of the Becraft Formation (Helderberg Group), overlain by the Oriskany Sandstone, which demonstrates the eastward stratigraphic rise of the Wallbridge Unconformity. Two meters of Oriskany Sandstone sit sharply on crinoidal grainstones of the Becraft Formation at this locality. Again, the Oriskany is dominated by quartz sand and large, thick-shelled brachiopods. The Oriskany is overlain by intermittent exposures of the Esopus and Schoharie formations of the Tristates Group.

HELDERBERG GROUP – KALKBERG, NEW SCOTLAND, AND BECRAFT FORMATIONS

This large road cut exposes three formations of the Helderberg Group: the top of the Kalkberg Formation (subunit D, including the *Mariacrinus stoloniferous* epibole), the Jefferson Heights and Leeds Gorge members of the New Scotland Formation (erroneously reported as Kalkberg Fm. in the 2005 Guidebook) and nearly all of the Becraft Formation (Text-fig. 3-6.1). Across the highway, on the westbound lane is the type section of the Punch Kill Unconformity between the Coeymans and Kalkberg Formations. Kalkberg subunits B, C and D are greatly thinned in that outcrop. Generally, work permits from the New York State Department of Transportation are required to visit the outcrops along Interstate 88.

Text-fig. 3-6.1: Members of the New Scotland Formation exposed along Interstate 88. Prominent reentrants in the Jefferson Heights Member are weathered tephra horizons. Several of these correlate with the tephras exposed on US 20 near Cherry Valley. The Becraft Formation (Old Stone Fort Member and B-2 facies) is exposed at the top of this outcrop.

The Jefferson Heights Member of the New Scotland Formation is thicker here than at Cherry Valley as a result of differential subsidence. Similarly, the overlying Leeds Gorge Member is also thicker, partly reflecting differential subsidence, but also more is preserved beneath the Becraft Formation and the Wallbridge Unconformity.

Several tephra beds are exposed through the Jefferson Heights Member and into the lower portions of the Leeds Gorge Member. Most yield euhedral microphenocrysts of zircon and apatite. Husson et al. (2016) reported CA-IDTIMS U-Pb dates for four tephras from this outcrop ranging in age from 418.42 Ma to 417.56 Ma. Ebert et al. (1992) reported seven tephra beds from this outcrop. Gamma ray profiles (Larsen et al. 2020; Wais and Ebert 2021) have enabled detailed correlations of these tephra beds. As with the greater thickness of the members of the New Scotland Formation at this location, the vertical spacing between correlative tephra beds is greater in the Schoharie area than at Cherry Valley. Chitinozoans from the tephra-bearing strata are representative of the upper *bohemica* zone. A sample from the lower portion of the Becraft formation yielded chitinozoans of the *lata* zone. The chitinozoan biostratigraphy indicates a middle Lochkovian age for the tephras. Ebert and Matteson (2019) suggested correlation of the tephra-bearing parts of the New Scotland Formation with the Lac au Renard Tephra Cluster in the Indian Point Formation from the Gaspé Peninsula in Québec. The Gaspé tephras occur in strata bearing graptolites of the *praehercynicus* zone, a correlation that is compatible with the chitinozoan biostratigraphy of the New York tephras.

Near the top of this outcrop, a minor disconformity at the base of the Old Stone Fort Member of the Becraft Formation marks the boundary between the New Scotland and Becraft Formations. The Old Stone Fort Member is correlative with the B-1 facies of the Becraft Formation in the Hudson Valley (JRE Stops 3 and 4). An erosionally thinned presentation of Becraft subfacies 2 (B-2) caps this outcrop.

HELDERBERG GROUP - BRAYMAN, COBLESKILL, RONDOUT, MANLIUS, AND COEYMANS FORMATIONS, INCLUDES SILURIAN – DEVONIAN BOUNDARY INTERVAL

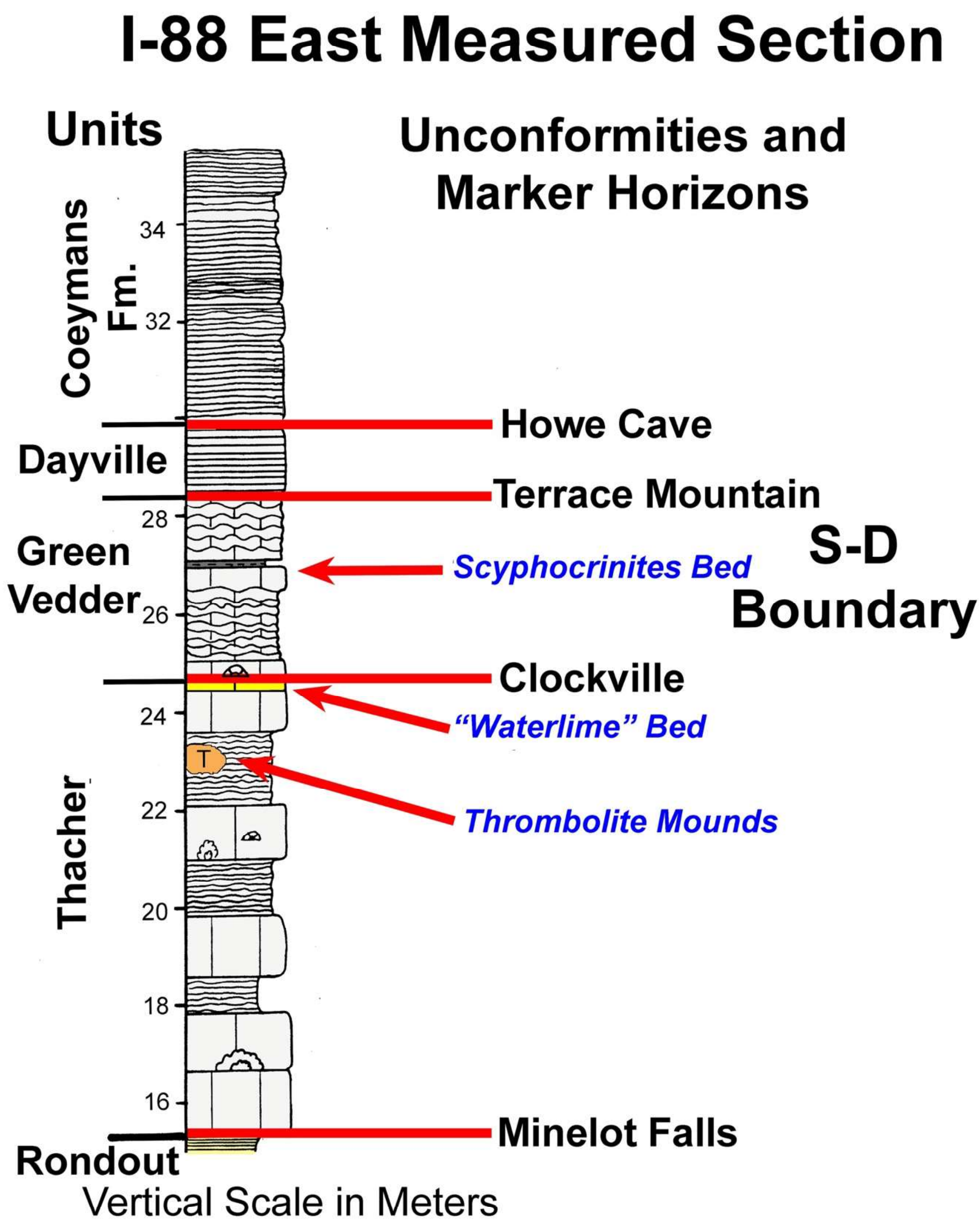
Numerous outcrops of the Silurian – Devonian boundary interval are present in the Schoharie area (e.g., see Grabau 1906). The most complete and best exposed of these outcrops is the large road cut along the eastbound lane of I-88. As with Stop 2A, NYSDOT work permits are required typically to visit this section.

The I-88 outcrop exposes a portion of the Silurian (Ludlow (?) to Přídolí) Brayman Shale at its base. The pyritic, calcareous Brayman Shale is unconformably overlain by echninoderm-stromatoporoid-coral rudstone to boundstone of the Cobleskill Member (Přídolí) (Johannessen, et. al. 1997) of the Rondout Formation. The unconformity is marked by a sharp lithologic change and the presence of well rounded, coarse to very coarse sand and granule-size grains of quartz.

Predominantly intertidal to supratidal cycles of the dolomitic to evaporitic Chrysler Member of the Rondout Formation are well exposed above the Cobleskill Member. The contact between the

Rondout and Manlius is sharp and is disconformable (Mine Lot Falls Unconformity) as indicated by the abrupt change in composition and by onlap relationships on a regional scale (Text-fig. 3-6.2; Ebert, 2018; Ebert and Matteson 2023). The Thacher Member of the Manlius Formation displays limestone cycles that represent intertidal to subtidal environments. There is a subtle increase in the subtidal components proceeding upward through the member.

Near the top of the cyclic portions of the Thacher Member, a relatively thick bed of peloidal packstone, overlain by a thin, dolomitic "waterlime," is truncated by a surface, which is littered with intraclasts and encrusted with in situ stromatoporoid colonies (Text-fig. 3-6.3). This surface, recognized by Goodwin and Anderson (1985, 1988) as a "sea level fall" surface, is the Clockville Unconformity (Ebert and Matteson 2003b). The top of the Clockville bed displays chaotic ripples and limited evidence (abrupt changes in relief) for early cementation and some encrustation with pyrite. This surface forms a broad bench near the top of the outcrop.



Text-fig. 3-6.2: A portion of the measured section from the I-88 East outcrop showing members of the Manlius Formation, significant disconformity surfaces, regionally correlative marker beds and position of the Silurian-Devonian systemic boundary. The boundary occurs within the middle to upper portions of the Green Vedder Member of the Manlius Formation. The Thacher Member of the Manlius Formation and the lower Green

Vedder Member are Silurian (likely Přídolían) in age. Whereas the upper Green Vedder and Dayville members of the Manlius Formation and the overlying Coeymans Formation are Lower Devonian (Lochkovian) in age.

Text-fig. 3-6.3: The Clockville Bed and Unconformity. At some localities, particularly in the west, this is a single disconformable surface. However, here it is a complex bed and series of surfaces marking a significant sequence boundary.

The Clockville Bed and Unconformity mark the base of the Green Vedder Member (Ebert and Matteson 2001 a, b; 2003a, b) of the Manlius Formation. The following description of the Green Vedder Member is modified from Wilson et al. (2011)

The Green Vedder is a distinctive, heterolithic unit with a diagnostic fauna and taphonomy (Matteson, Natel and Ebert 1996; Ebert and Matteson 2003a, b). Skeletal and peloidal packstones, wackestones and mudstones (1-18 cm beds; average 5-7 cm) alternate with interbeds of dark, carbonaceous shale (0-6cm) (Fig. 10). A thick, amalgamated bed occurs in many outcrops, informally termed the Thick Middle Bed (TMB; Fig. 10).

Carbonate beds of the Green Vedder display sharp bases and planar to laminated undulatory tops. Many are graded. Topmost laminae are dolomitic and slightly pyritized (Matteson et al. 1996). Many beds are discontinuous laterally because they comprise large-scale hummocks (20-50 cm wavelength and up to 12 cm amplitude). Some hummocks alternate with broader swales (~1 to 2 meters). In the Schoharie area, hummocks display much shorter wavelengths. These short wavelength hummocks are interpreted as large ripples. Extensive bioturbation obscures most internal structures. Infiltration fabrics are common in the coarser packstones. Gutter casts are present along the bases of some beds. The carbonate beds of the Green Vedder Member are interpreted as tempestites, deposited on an open shelf below fair-weather wave base, but above storm wave base.

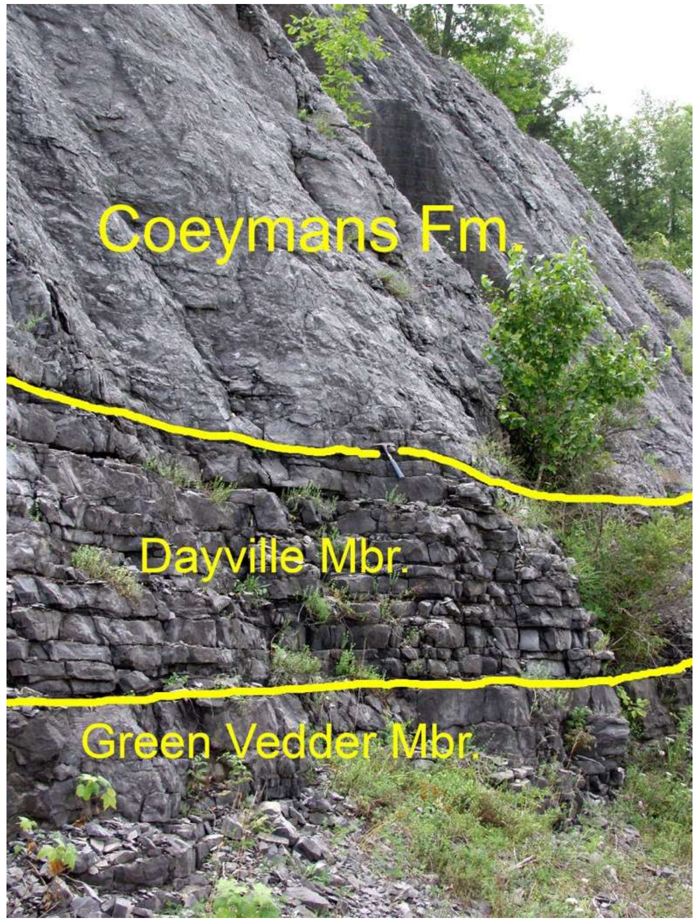
Thin, skeletal-rich firmground/hardground grainstone horizons (sub mm to ~2 cm) and/or shell pavements are common in Green Vedder strata. Skeletal material within these condensed horizons is slightly pyritic. Stacked hardgrounds comprise most of the member in the Hudson Valley.

Limestone beds of the Green Vedder Member are interbedded with black to gray, organic-rich shales. Shales in the Green Vedder represent long intervals of sediment starvation during which many organisms were excluded, but a soft-tissue biota including bacterial mats, scolecodont-bearing worms, the alga *Medusaegraptus*, and fragments of early, vascular land plants (e.g., *Cooksonia*) has been preserved.

The relatively deep, subtidal environment recorded by the Green Vedder Member represents transgression above the Clockville Unconformity.

The upper Green Vedder Member is cut sharply by an undulose surface, the Terrace Mountain Unconformity, which underlies the first echinoderm grainstone bed of the Dayville Member (Text-fig. 3-6.4; previously assigned to the Coeymans Formation). Previously, Rickard (1962; 1975) had restricted the Dayville Member to Cherry Valley and west. However, the Dayville, now a part of the Manlius Formation, is not only present in the Schoharie area; it has been traced as far east as Gallupville where it thins to disappearance (Ebert and Matteson 2003b).

The Dayville has been substantially thinned from 4 m at Cherry Valley to approximately 1.9 m at this outcrop and down to less than one meter at other outcrops in the Schoharie area. This thinning is attributable to the eastward descent of the Howe Cave Unconformity, which separates the Dayville from the overlying Coeymans Formation.



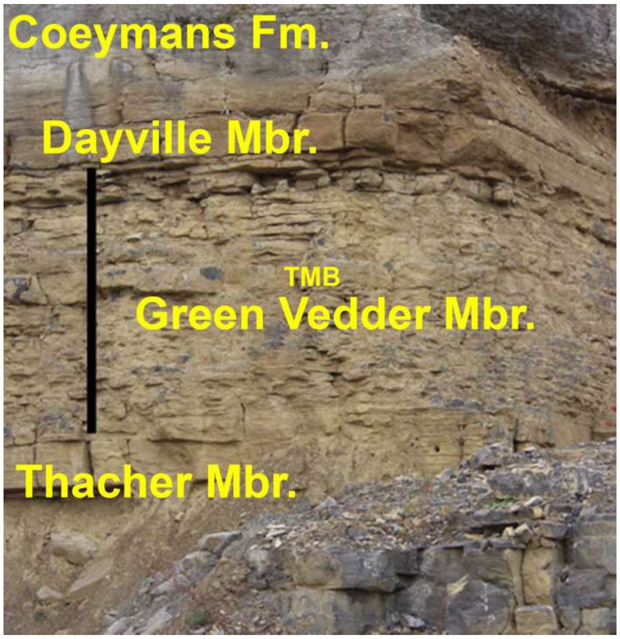
Text-fig. 3-6.4: Upper portion of the I-88 East outcrop. Two members of the Manlius Formation overlain by the Coeymans Formation. The Green Vedder – Dayville contact is the Terrace Mountain Unconformity. The Coeymans Formation rests on the Howe Cave Unconformity.

The Coeymans Formation comprises coarse skeletal packstones to grainstones, with channel-like bodies of coarser skeletal grainstone. Favocitid corals and rare stromatoporoids occur throughout the unit and are typically loose clasts. However, in rare occurrences, colonies are demonstrably *in situ* and may mark local hardgrounds. The upper 2.2 meters of the Coeymans Formation contain abundant holdfasts of *Lepocrinites gebhardi*. This is a minimum thickness for the *gebhardi* zone in this area as the top of the outcrop is glacially truncated. In the nearby Howe Cave Quarry, the *gebhardi* zone is over 4 meters thick.

<u>Optional Stop:</u>

HOWES CAVE QUARRY AND CAVE HOUSE MUSEUM OF MINING AND GEOLOGY: THACHER, GREEN VEDDER AND DAYVILLE MEMBERS OF THE MANLIUS FORMATION, COEYMANS FORMATION

The active Howe Cave Quarry exposes most of the Thacher Member of the Manlius Formation, the Green Vedder and Dayville members of the Manlius Formation, and the entirety of the



Text-fig. 3-6.5: The Green Vedder Member of the Manlius Formation exposed adjacent to the Howe Cave Museum of Mining and Geology. The regionally traceable Thick Middle Bed (TMB) occurs slightly above the center of the Member. The systemic boundary between the Silurian and Devonian occurs in the vicinity of this marker bed.

Text-fig. 3-6.6: Scyphocrinitid lobolith from the Green Vedder Member of the Manlius Formation. The global epibole of scyphocrinitids occurs at or slightly above the base of the Lochkovian and is thus an excellent proxy for the Silurian – Devonian boundary. This figure was included in the 2011 NYSGA Field Trip Guidebook. Used with permission from NYSGA.

Coeymans Formation. A few meters of the Kalkberg Formation (subunit D) cap the exposure. Access is restricted owing to active quarrying operations. However, there is an accessible section adjacent to the Cave House Museum of Mining and Geology. This section includes the top of the Thacher Member, the Green Vedder (Text-fig. 3-6.5) and Dayville members of the Manlius and the Coeymans Formation. Plate loboliths of *Camarocrinus stellatus* (Text-fig. 3-6.6) have been collected from the mid- to upper Green Vedder Member here, indicating the approximate position of the Silurian-Devonian boundary.

I-88 Cuts to Howe's Caverns:

0.0 mi	Head northeast on I-88 E
1.9 mi	Take exit 23 for NY-30A
0.35 mi	Turn Left onto NY-30A N
0.31 mi	Turn Left onto NY-7 W
4.67 mi	Turn Right onto Caverns Rd.
1.23 mi	Turn Right to stay on Caverns Rd.
0.22 mi	Turn Right onto Discovery Dr. towards Howe Caverns Motel

END DAY 3