EIGHTEEN MILE CREEK: SOUTH BRANCH TO LAKESHORE; MIDDLE TO UPPER DEVONIAN SHALES

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INTRODUCTION

For logistical purposes, we will run this trip "backwards" in geologic time. We will start at the headwaters of Eighteen Mile Creek South Branch on the Appalachian Plateau. We will then begin to descend the plateau as the creek incises into the Upper Devonian shales. In these exposures, we will be able to observe important markers within the Late Devonian, including both the Lower and Upper Kellwasser extinction horizons. As we journey further back into geologic time, we will observe shales deposited during times of less environmental stress and, finally, we will end at the Lake Erie shoreline which provides excellent fossil collection opportunities. This morning trip serves as a companion trip to the afternoon "Penn Dixie Fossil Park & Nature Reserve: A Window into the Devonian Period of western New York" and the final portion of the road log will take us to the quarry where that trip will begin. Eighteen Mile Creek is named not for its length, but for its distance along the Lake Erie shoreline from the mouth of the Niagara River. The mouth of the Buffalo River, which would eventually become the terminus of the Erie Canal is about 2miles closer. These major navigable waterways were vital to the indigenous peoples, later colonial communities, and the industrial history of the area. On this trip, we will be visiting the locations of two of the earliest mills along the creek (Stops 2 & 3). In addition to powering mills, Eighteen Mile Creek and its valleys and floodplains provide fertile soils which continue to support a vibrant agricultural industry, particularly sweet corn, which is celebrated annually during Eden's Corn Festival (1st weekend in August).

The lower gorge and lakeshore sections have been a popular site for previous NYSGA field trips. These trips mostly sought to analyze a specific stratigraphic section (e.g., Zambito and Mitchell, 2006 – Wanakah Member; Lash and Blood, 2006 – Rhinestreet Member) or to address specific geological / paleontological problems (e.g., Over et al., 1999 – Disconformities; Baird et al., 2006 – Geologic and Biotic Event horizons). This trip is meant to serve as a comprehensive overview of the creek itself, primarily the South Branch, but it also provides some optional stops along the main (northern) branch. The Eighteen Mile Creek gorge can be intimidating and may seem unapproachable at first. This trip will highlight areas that provide relatively easy accessibility for other researchers and students who may wish to study these intervals in more detail. For this purpose, the trip also provides a broad sampling of the stratigraphy (ranging from Middle Devonian (Givetian) Wanakah Member up through the Late Devonian (Famennian) Dunkirk Member. From a paleontological perspective, we will see fossil communities thriving along the lakeshore section (and later at Penn Dixie Fossil Park in a separate afternoon trip) and higher in the section, we will explore outcrops surrounding the Kellwasser Events, where these fauna were stressed or eliminated.

Geological Setting

On this trip, we will be examining rocks (mostly shale) from the Middle to Late Devonian. These sediments were deposited into the Appalachian foreland basin, which is associated with compression related to the Acadian Orogeny (Figure1). At the time of deposition, the study area was positioned approximately 20° south of the Equator (Scotese and McKerrow, 1990). The sediments were primarily derived from the erosion of the Acadian Mountains with sediments generally fining to the west in a prism known as the Catskill Clastic Wedge (or Catskill Delta). Figure 2 illustrates the recurrent unconformities associated with the cratonward migration of the peripheral bulge and the tongues of black shale that are associated with the subsequent flexural deepening of the basin during more active

pulses of tectonic activity and crustal loading in the Acadian Orogen (Ettensohn, 1994). This flexural deepening of the basin and the westward distal position within the basin results in the stratigraphy of the study area (Figure2) being dominated by shales and silty shales with only the occasional pulse of coarser material (usually pinches out east of the study area) and carbonates during times of lower relative sea-level and/or higher biologic productivity.

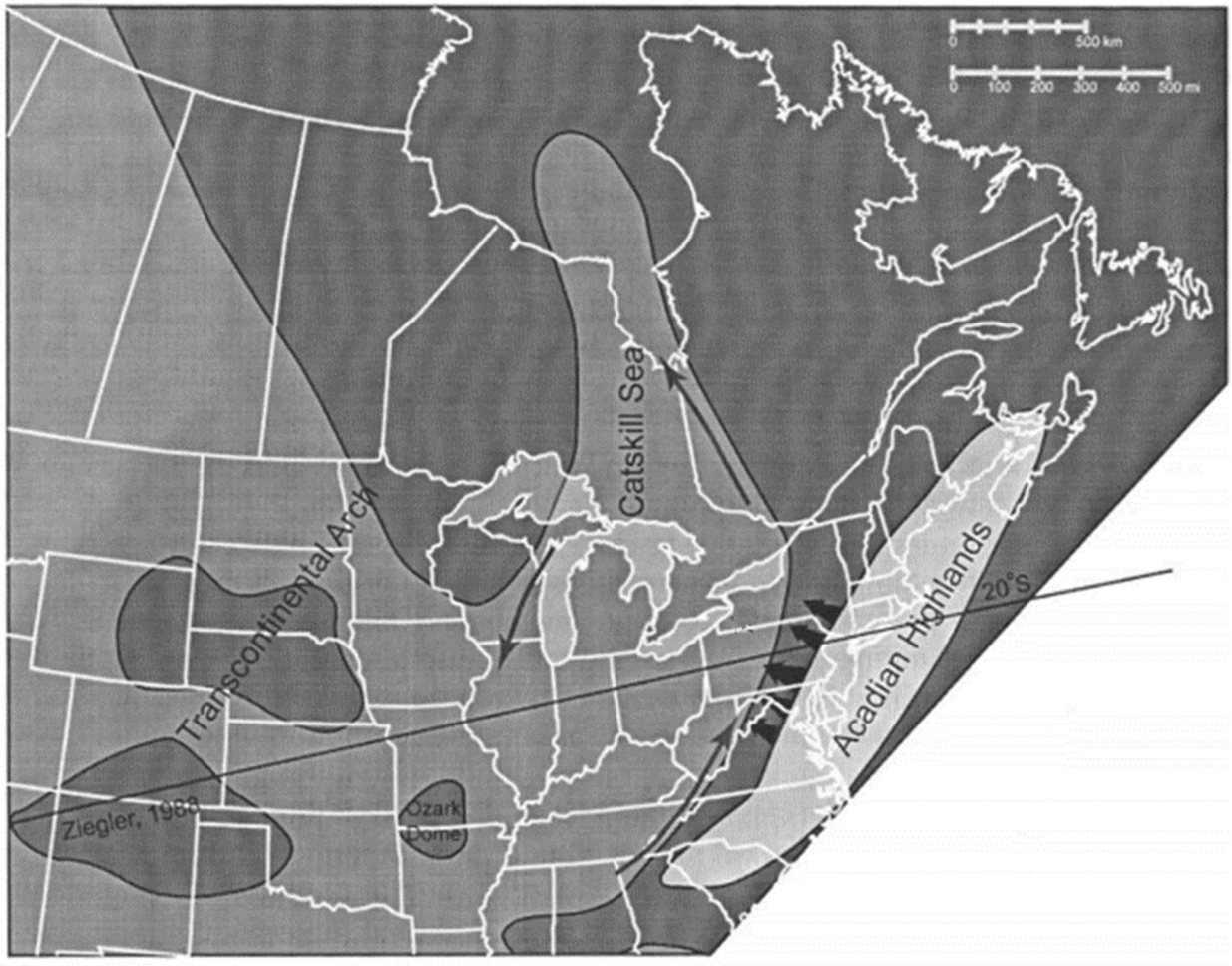

Figure1. Devonian Paleogeography showing Catskill Sea (Appalachian Basin) and Acadian Highlands. 20°S latitude parallel based on paleomagnetics of Ziegler (1988). From Smith and Jacobi (2006).

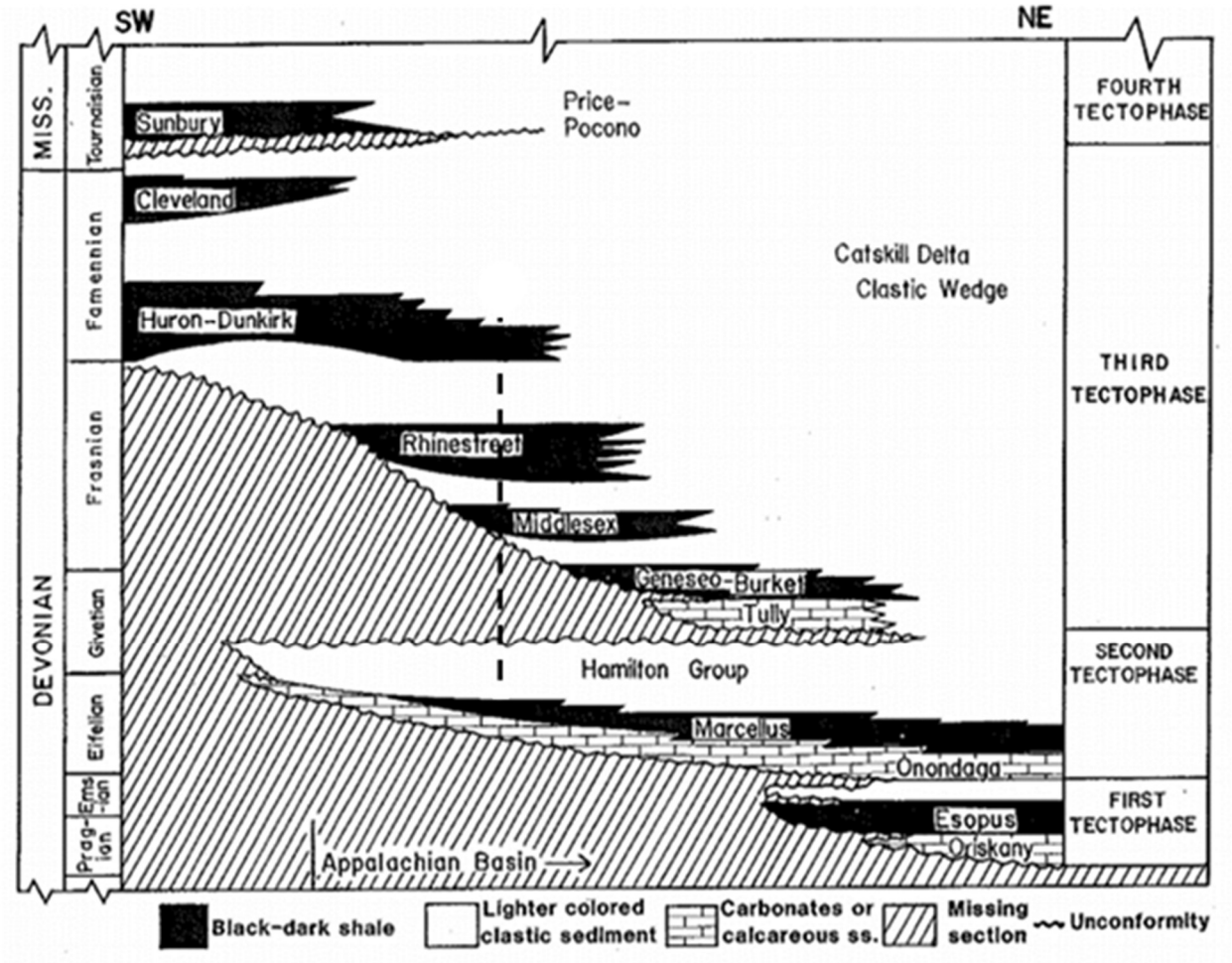

Figure2. Composite stratigraphic section from north-central Ohio (SW) to east-central New York (NE) through the northern portion of the Appalachian Basin. The dashed black line indicates a very approximate location and interval covered in this trip. From Ettensohn (1994).

The Late Devonian is also a time of major faunal disruption. Raup and Sepkoski (1982) assembled family-level fossil data from both vertebrates and invertebrates and identified 4 Phanerozoic intervals when extinction exceeded the background rates, deemed mass extinctions (Fig3A). A 5th event (Devonian) was also above background, but not statistically significant, as this extinction is "smeared" across three different stages: Givetian, Frasnian, and Famennian (Raup and Sepkoski, 1982). The Devonian mass extinction is more accurately a series of major extinction events. Despite being less abrupt than the end Ordovician mass extinction, Droser and others (2000) assert that the Devonian extinction(s) were more ecologically impactful. Sepkoski and Miller (1985) indicate that from the Ordovician onwards the Paleozoic fauna were gradually being displaced from the shallow shelf environment and into deeper water by the Modern fauna (solid line, Fig3B), but the Devonian extinctions reverse this trend until well into the Carboniferous. However, these extinctions do essentially mark the end of the trilobite-dominated Cambrian fauna (dashed line, Fig3B). Although trilobites linger to the end Permian mass extinction, they never return to the abundance and diversity observed in the Devonian (as at Stop5 and in the afternoon Penn Dixie Fossil Park trip).

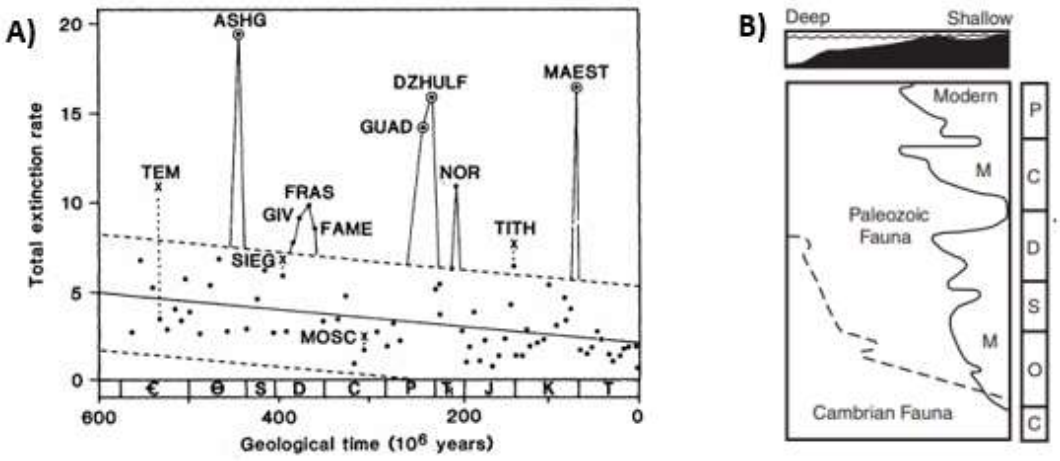

Figure3. Impact of Phanerozoic Extinction Events. **A)** Family-level extinction rates by geologic Stage from Raup and Sepkoski (1982). GIV – Givetian, FRAS – Frasnian, FAME – Famennian. Dashed lines represent range of "background" extinction. Spikes above this background rate are mass extinctions. **B)** Ecological reordering through time from Sepkoski and Miller (1985). Dashed line separates Cambrian Fauna and Paleozoic Fauna, Solid line separates Paleozoic Fauna from Modern Fauna

In addition to their geologic and paleoecologic importance, these Devonian shales are also significant sources of hydrocarbons in New York State and elsewhere within the Appalachian Basin. In fact, the first gas well in North America was drilled near Fredonia in 1821 (Hill et al., 2004) in Devonian shale. This shallow well likely produced out of the Dunkirk Member, which we will see at Stops 1 and 2. Chestnut Ridge Park and the Eternal Flames Falls are atop the next topographic ridge to the northeast from the Eighteen Mile Creek valley. Etiope and others (2013) geochemically finger-printed the source of this naturally occurring gas seep as the Rhinestreet shale, which we will see at Stop4. These hydrocarbons seep up along dominant fracture sets (Jacobi and Fountain, 2000; Schimmelmann et al, 2018) which also guide the topography of the area. Farther to the south and higher in the stratigraphic section the first oil "well" in North America was the Seneca (Cuba) Oil Spring in Cuba, NY as described in Van Tyne (2006) and the first actual oil well (the Drake Well) near Bradford, PA (Owen, 1975).

Previous Investigations

Amos Eaton (1830) published his geologic map of New York State just 15 years after William Smith's famous geologic map of England ("The Map that Changed the World"). According to its website, the New York State Geological Survey was established in 1836 and James Hall (one of Eaton's students) was named the first state Paleontologist and director of The New York State Museum. Since these early days, the rocks of New York State have been an outdoor laboratory to develop and test emerging geological and paleontological principles.

More specific to Eighteen Mile Creek, Amadeus Grabau (1898) published an extensive review of the geology and paleontology of the main branch of Eighteen Mile Creek starting at the Lake Erie shoreline and moving upstream to the present-day railroad bridge between Rts 5 and 20. Brett (1974) contains a basemap with Grabau's original numbered sections located on a topographic map. Over and others (1999) provide a detailed stratigraphic examination of this area (Figure4). We will be examining the Wanakah and Tichenor Members at Stop5 of this trip (and during the afternoon trip to Penn Dixie Fossil Park & Nature Reserve).

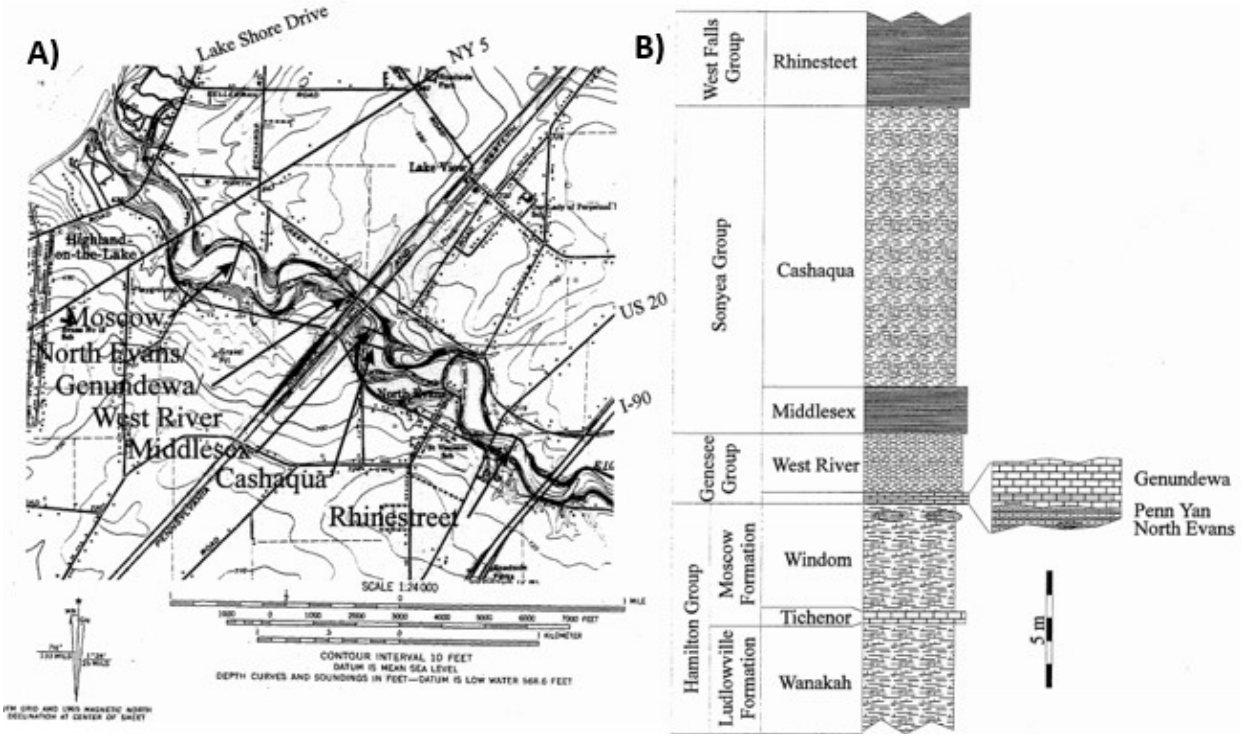

Figure4. Stratigraphic units of the lower reaches of Eighteen Mile Creek (main branch). **A)** Stratigraphic contact location (at creek level). From Over and others (1999). **B)** Measured section of this same interval. From Over and others (1999).

Grabau (1898) states that "the upper gorge and branches have not been examined", but the gorge and exposures continue well upstream from the Thruway bridge and extend up both the main branch and the south branch. Lash and Blood (2006) provide a focused stratigraphic (Figure5) and petrographic analysis of the Rhinestreet black shales near the confluence of these branches ("The Forks", Stop4 of this trip). Their guide focuses on the hydrocarbon potential for these organic-rich black shales. The older Marcellus shale and other hydrocarbon-bearing shales around the United States (e.g., Eagle Ford, Permian Basin, Barnett, etc.) currently garner most of the attention, but Hill and others (2004) provide a comprehensive survey of other potential targets in New York State. One of the more notable features within the Rhinestreet are the often very large 1m+ diameter internally laminated septarian carbonate concretions, which Grabau (1898) referred to as "turtle stones", "turtle backs", or "petrified turtles". These concretions form in a few discrete layers within the unit, which Lash and Blood (2006) cite as one piece of evidence that they likely formed near the seafloor shortly after deposition. Many concretions are visible *in situ* in the banks of the gorge and some excellent examples have weathered out and can be readily examined at creek level. The rigid concretions create stress shadows at their margins that preserve the initial "house of cards" depositional fabric of the clay grains, which is usually quickly lost throughout the complicated burial and compaction history of these shales (Lash and Blood, 2006).

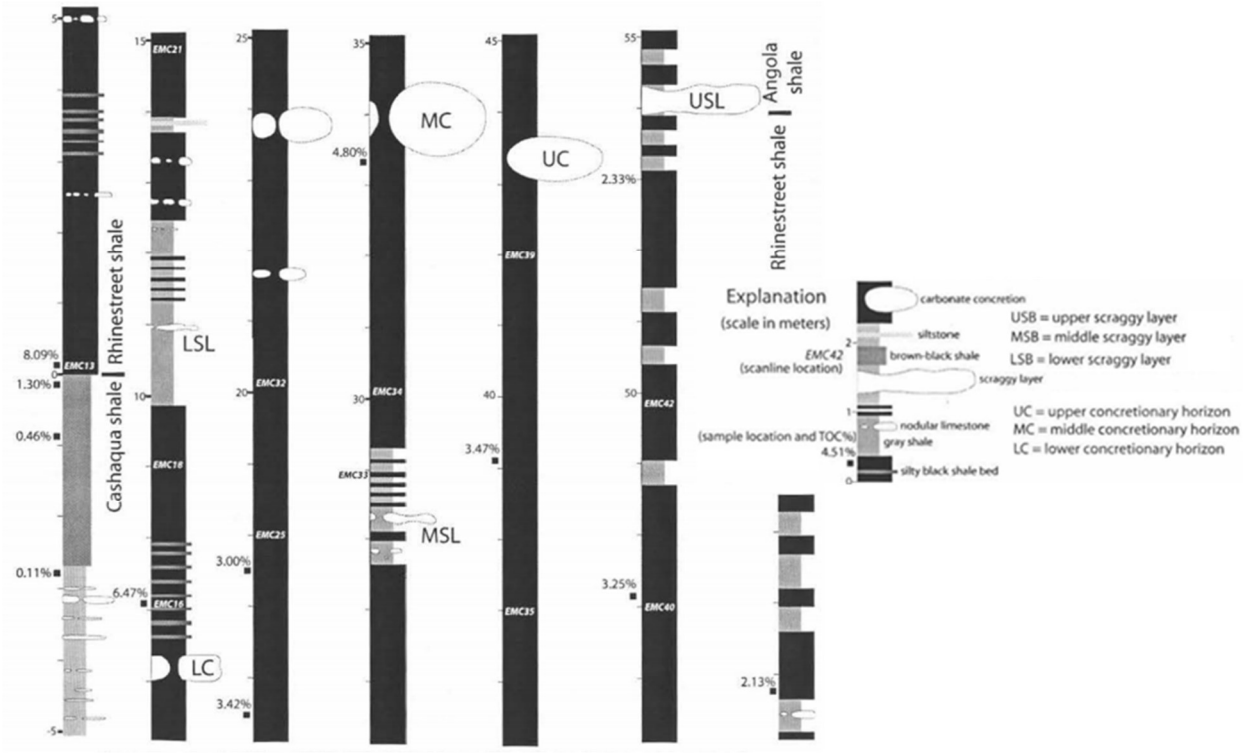

Figure5. Stratigraphic column of the Rhinestreet interval at "The Forks" area of Eighteen Mile Creek. Note that the column wraps around with the lowest portion of the section at the lower left and the highest portion at the far right. From Lash and Blood (2006).

Upstream from "The Forks", the creek divides into the main (northern) branch which flows through the Village of Hamburg and the South Branch which flows through the Eden Valley. For purposes of this trip, we will be focusing on the South Branch as the exposures are more consistent, however, we have also provided a list of relevant places along the main branch at the end of Stop4. Heading upstream on the South Branch, the gorge becomes less steep and widens near the historic Eden Valley Mill. The outcrop in this area is somewhat limited until the creek approaches Rt75 (Sisson Highway).

At Kromer's Falls near OId Mill Run Rd, we will examine the Lower Kellwasser Bed, which is the first of three major ecological disruptions in the Late Devonian: Lower Kellwasser Event, Upper Kellwasser Event, and the Hangenberg Event which occurs at the Devonian-Carboniferous boundary. The Kellwasser Beds were first defined by Schindler (1990) from the Late Devonian sections of Europe and Morocco. These events were initially recognized in western New York by Over's (1997) analysis of conodont biostratigraphy. Bush and others (2015) have recently revised the correlations of the basinal black shales (such as along Eighteen Mile Creek) with the more proximal coarser-grained deposits to the SE and their later field trip (Bush and others, 2017) extended these correlations into Pennsylvania. It can be difficult to recognize these ecological crises in the black shales since even outside of these crises the fauna of the deep basin are low abundance/diversity. Boyer and others (2014) analyzed burrow size and density (particularly of *Chondrites*) and trace metal content (molybdenum) as a proxy for bottom-water oxygen levels and the resulting environmental stress across the Upper Kellwasser interval. Both the Lower and Upper Kellwasser Events were stops on Baird and others (2006) field trip and their detailed stratigraphic sections are provided below (Figure6). Their Stop6 corresponds to our Stop3 and their Stop7 corresponds to our Stop1. We will also visit the post-Upper Kellwasser Dunkirk Member (Stop2).

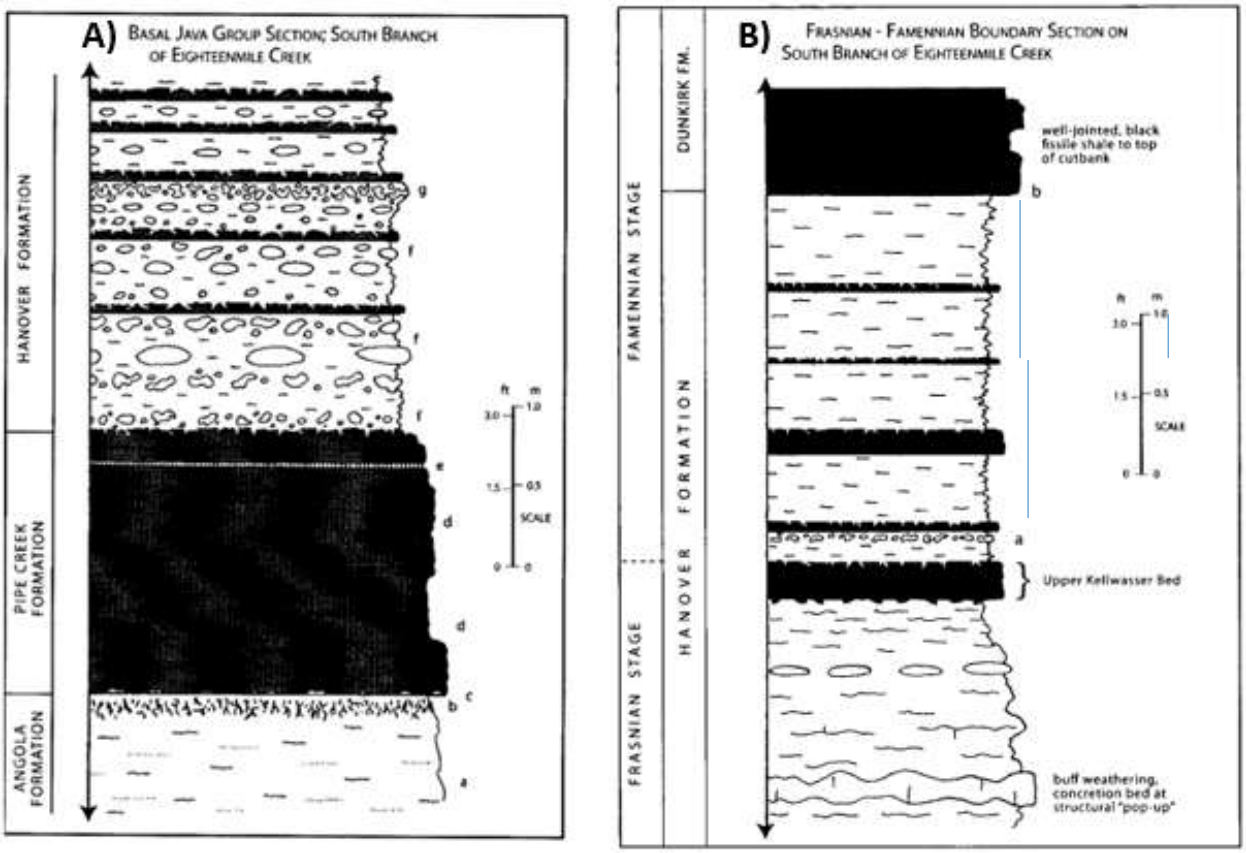

Figure6. Stratigraphic sections through the Kellwasser Events along Eighteen Mile Creek South Branch. **A)** Lower Kellwasser Event as seen at Kromer's Falls (Stop3) **B)** Upper Kellwasser Event as seen near New Oregon Rd Bridge (Stop1). From Baird and others (2006).

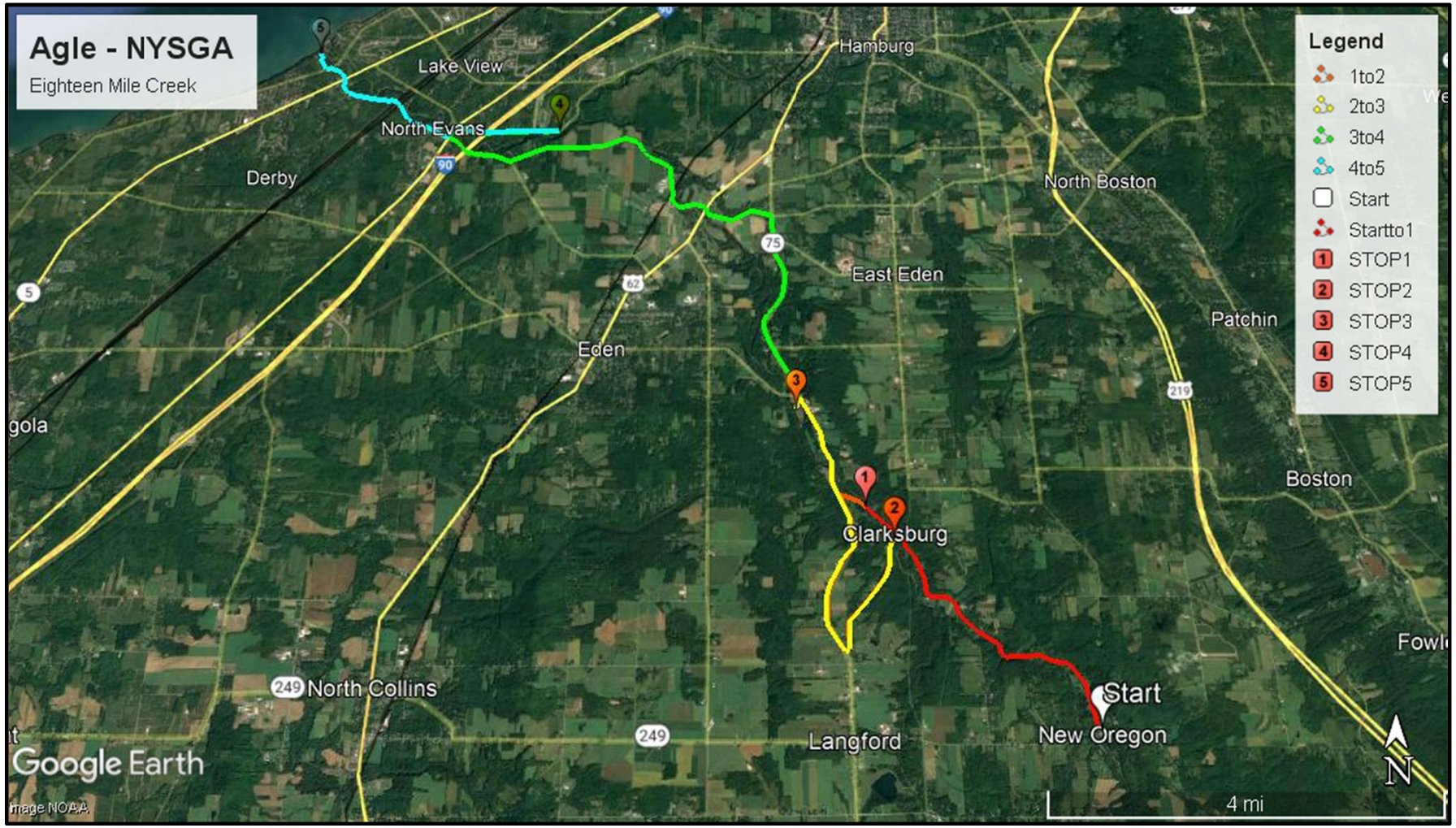

Figure 7. Location Map and Trip Route. Start – Frances Danter Memorial Park (corner of Langford and New Oregon Rds in New Oregon, NY); STOP1: New Oregon Road Bridge; STOP2: Clarksburg Country Club; STOP3: Kromer's Falls; STOP4: Eighteen Mile Creek Park; STOP5: The Bluffs; Please join us at Penn Dixie Fossil Park & Nature Reserve (4050 North St, Blasdell, NY 14219) for the afternoon trip. Basemap from Google Earth.

FIELD GUIDE AND ROAD LOG

If you are coming from the Buffalo area, you will want to take 219 South towards New Oregon, NY. Along the drive you will encounter a few Points of Interest (POI):

POI: Armor Duells Rd exit for Chestnut Ridge Park (do not Exit). This park is home to the Eternal Flame Falls, which is a dramatic illustration of the hydrocarbon potential of the Devonian shales that we will observe on this field trip.

POI: Continuing south on 219 near the 55.6 mile marker, you will cross a small tributary of the north branch of Eighteen Mile Creek. You will then start uphill onto the Appalachian Plateau

POI: At the Zimmerman Rd overpass, you will drive past some excellent outcrops of the Canadaway Group shales in a series of roadcuts.

Use the Rice Hill Road Exit, turn right on Rice Rd, then turn left onto Zimmerman Rd and head south, go straight through the intersection with Fennick Rd and Brown Hill Rd (Zimmerman will become Brown Hill Rd), turn right onto Langford Rd and head west into New Oregon.

POI: As you get nearer New Oregon, you will notice several large glacial erratics used as landscaping stones (such as at Boston Fire Co 2)

Meeting Point: Francis Danter Memorial Park in New Oregon (corner of Langford & New Oregon Rds)
Meet at or near the Pavilion *Chemical toilet on site*
Meeting Point Coordinates: 42.5886°N, -78.7913°W
Meeting Time: Saturday, September 25th @ 8:45am (We will leave at 9am. If you are running late and we've already departed, use the Road Log below to locate the group)

Distances in miles		
Cumulative	Point-to-Point	Route Description
0.0	0.0	Turn right out of Francis Danter Memorial Park, heading N on New Oregon Rd
1.1	1.1	POI: Kern 1 well (National Fuel Gas), penetrates to Queenston producing out of Medina SS. Outcrop of Canadaway Group in creek behind well with small waterfall
1.3	0.2	POI: Shear road cut exposure of Canadaway Group. Shoulder is often VERY soft
1.6	0.3	POI: Bridge over creek with some decent outcrop
2.1	0.5	POI: Cement driveway bridge across creek with easy access to pavement outcrops of Canadaway Group
3.4	1.3	POI: Intersection of New Oregon Rd and Clarksburg Rd (Clarksburg Bridge). Would be Stop1, but bridge is out. We will detour around and visit as Stop2
3.8	0.4	**STOP1:** Park on right shoulder in front of garden, just before the New Oregon Rd bridge over Eighteen Mile Creek South Branch

STOP1: New Oregon Rd Bridge, Upper Kellwasser Bed: Frasnian-Famennian boundary

Location Coordinates: 42.62488°N, -78.8380°W

At this location, we will examine the Upper Kellwasser horizon in outcrop. The interval is visible in the cutbank just to the NW of the New Oregon Rd bridge as the creek makes a turn towards the NE and heads towards Sisson Highway. This location is Stop7 of Baird and others (2006) and they provide an in-depth review of the interval, including a measured section, which is reproduced herein (Figure6B). The Upper Kellwasser Bed lies 2.4m below the abrupt contact between the Hanover Member and the overlying black shales of the Dunkirk Member (which we will also see at Stop2). This bed within the upper Hanover marks the Frasnian-Famennian boundary and a major faunal disturbance.

Distances in miles		
Cumulative	Point-to-Point	Route Description
4.2	0.4	Continue on New Oregon Rd to intersection with Route 75 (Sisson Highway). Turn left onto Rt75 heading south

4.2	0.0	POI: Immediately after turning onto Rt75, there is a small tributary on the right with a series of small waterfalls
6.1	1.9	Turn left onto Clarksburg Rd
7.5	1.4	**STOP2:** Clarksburg Country Club. Turn right into driveway (just before bridge) and park along the wood fence near the green bathroom buildings

STOP2: Clarksburg Country Club, Dunkirk Shale ******should*** be STOP1, but bridge is out***

Rustic bathrooms available on-site

Location Coordinates: 42.6188°N, -78.8313°W

Unfortunately, the Clarksburg Rd Bridge is out which will force us to detour around. The locals informed me that a propane tanker truck lost its brakes coming down the hill and the driver was forced to bail out before the truck hit the bridge. Fortunately, there were no major injuries aside from the bridge as the engine block tore through the plate steel. The falls here mark the historic location of Simeon Clark's Mill (circa 1820) for whom the town is named. The face of the falls is composed entirely of highly fissile, organic-rich, black shales of the Dunkirk Member.

Distances in miles Cumulative	Point-to-Point	Route Description
7.5	0.0	Turn left out of Country Club driveway heading S on Clarksburg Rd
9.0	1.5	Turn right onto Rt75 (Sisson Highway) and head NE
11.3	2.3	POI: Bridge over creek with nice pavement outcrop and small waterfall in creek bed
12.1	0.8	Turn left onto East Church St
12.1	0.0	Almost immediately, turn left onto Old Mill Run Rd
12.4	0.3	**STOP3:** Kromer's Falls. Drive past the two private residences and park at the end of the driveway in front of the out-buildings near No Trespassing signs

STOP3: Kromer's Falls, Lower Kellwasser Bed (Pipe Creek Member)

Location Coordinates: 42.6415°N, -78.8519°W

The falls here also powered an historic mill and the area around it was referred to as Toad Hollow. Kromer's sawmill operated here into the 1980s when the roof collapsed during a winter storm. The foundations of the mill are still visible. This location is Stop6 of Baird and others (2006) and they provide an in-depth review and stratigraphic column which is reproduced herein (Figure6A). Most of the face of the falls is composed of gray silty, bioturbated shales of the Angola Member, but the falls is capped by the well-jointed black shale of the Pipe Creek Member. Bioturbation diminishes upward within the Pipe Creek and it is laminated at the top of the falls, indicative of the major faunal disturbance associated with the Lower Kellwasser Event.

Distances in miles Cumulative	Point-to-Point	Route Description
12.5	0.2	Go back out the driveway and turn right onto East Church St
12.5	0.0	Almost immediately, turn left onto Rt75 (Sisson Highway)
13.9	1.4	POI: Bridge over small tributary that exposes some section in a series of small waterfalls up Schintzius Hill
15.2	1.3	Turn left onto North Boston Rd @historic St. Paul's Lutheran Church
16.0	0.8	Turn right onto Eden Valley Rd

16.1	0.1	Go straight through the intersection with Rt62 (Gowanda State Rd) onto Bley Rd
16.4	0.3	POI: Where Mill Rd intersects with Bley Rd, there is an access road on the right that will bring you to the site of Eden Valley Mills (still standing), one of the historic mill locations along the creek. The creek bed is mostly covered through the relatively low-relief Eden Valley.
16.6	0.2	Turn right onto Belknap Rd. This road roughly parallels the creek (it is just beyond the treeline to the right). The gorge deepens dramatically in this area and access to creek level is not easy from above.
18.4	1.8	Gentle right onto Bauer Rd
19.3	0.9	Turn right onto Shadagee Rd
19.9	0.6	POI: We will pass under the Thruway bridge here. If you are ever travelling on the 90 (and not driving!), this bridge provides a good view of the gorge
20.2	0.3	Turn right onto Rt20 (Southwestern Blvd). Note: If you park at the North Evans / St. Vincent de Paul Cemetery, there is a fairly steep footpath (public fishing access) across Shadagee Rd (north side) that leads down to the flat areas at creek level, providing some views of the gorge although it is now mostly overgrown.
20.4	0.2	Cross the bridge and turn right to head E on North Creek Rd. The gorge is now on our right. This time we will go over the Thruway (20.8)
22.1	1.7	**STOP4:** The road winds along the rim of the gorge. After a sign that says "Slides" and a 20mph left bend sign, park facing the "wrong" way on the left shoulder (wider and paved) just as the road starts to bend towards the North. Across the road, there is a very small gap in the retaining barrier that leads to a footpath down to the main branch of Eighteen Mile Creek.

STOP4: The Forks @ Eighteen Mile Creek Park, Rhinestreet Member

Location Coordinates: 42.6969°N, -78.9088°W

The footpath provides a relatively easy descent into the gorge with outcrop in the path itself and along the right-hand side. This is the best opportunity to examine the Rhinestreet Member up close as the gorge walls here are quite steep and inaccessible. Near the bottom of the path, an ephemeral waterfall on a small tributary exposes some large septarian carbonate concretions within the black shales. Lash and Blood (2006) provide an in-depth analysis of this interval, the concretions, and a detailed stratigraphic section that is provided herein (Figure 5). Once you are at creek level, if you walk upstream you will come to The Forks (the confluence between the main branch and the South Branch of Eighteen Mile Creek.) In this area, there are several large concretions that have weathered out of the banks and now rest among the talus and alluvium. This land is currently being developed into Eighteen Mile Creek Park with footpaths providing easy access both upstream and downstream from this location.

****Alternate stops (upstream on main branch of Eighteen Mile Creek)****

If you'd prefer to work your way up the main branch of Eighteen Mile Creek rather than proceed downsection to the lake shore, there are a few interesting stops along the way. If you continue eastward on North Creek Rd you will continue to parallel the gorge, but access from above is very difficult. Make the first possible left (Lakeview Rd) and then turn right onto Lakeview Rd. The Town of Hamburg Recreation Center is near this intersection and there is a moth-balled Cold War Era Nike Missile Base (BU-52) on its grounds. According to the Hamburg Historical Society website, this missile base (and others) protected the Buffalo population center and the steel and iron industries of the area.

The intersection of Lakeview Rd and Old Lakeview Rd is directly across from the Recreation Center. If you take Old Lakeview Rd to the intersection with Smith Rd there is a sharp meander in the creek. Turn right onto the onto South Creek Rd bridge (42.7117°N, -78.8695°W) and to your right you can see a cable stretched across the creek with Posted signs strung across it. Beneath the cable on the SW wall of the gorge, there is a small tunnel (barely high enough to stand) that goes entirely through the meander (do not enter without permission!) at creek level. This tunnel is another callback to the industrial history of the area as it served as the upstream head race that powered a grist mill and the tail race comes out downstream of the falls on the other side. According to the nearby historical marker, this mill was erected in 1806 by John Cummings and was the first grist mill south of Buffalo.
Upstream from this location, towards the town of Hamburg, the gorge becomes shallower and much less steep. The creek is readily accessed from Woodview Park (Woodview Ave) and from Centennial Gardens Park (corner of Main St and Buffalo St). The creek continues behind Eighteen Mile Creek Golf Course and even across Rt219, but outcrop is limited.

Distances in miles Cumulative	Point-to-Point	Route Description
22.1	0.0	Make a safe U-turn (be careful of the blind corner). Head back to the W on North Creek Rd
23.8	1.7	Turn left onto Rt20 (Southwestern Blvd), go back across the bridge
24.0	0.2	Just across the bridge, turn right onto South Creek Rd. This road parallels the gorge with a few areas where access is possible (but mostly difficult)
24.3	0.3	POI: If you turn right on Versailles Rd, you will descend to creek level to Hobuck Flats parking area. There is a footbridge across the creek, easy access to creek level, and a short hike (stay on lower path) to a waterfall on a small tributary.
24.9	0.6	POI: We will go under a set of railroad tracks. The creek can be accessed from near the railroad bridge, but it is not recommended
25.8	0.9	Go straight through the intersection with Rt5. There is a way down to creek level at the Rt5 bridge, but this is also not recommended
26.1	0.3	Turn left onto Old Lakeshore Rd
26.2	0.1	Turn right into The Bluffs private community. This location should absolutely not be accessed without prior permission from the residents
26.4	0.2	Continue straight on Old Manor Rd, veer left toward Learmont Dr (follow sign), continue straight on Learmont Dr until the road dead-ends
26.4	0.0	**STOP5:** Park along the fence near the pool (with permission) and head through the unlocked gate (key from resident) and down the footpath to lake level

STOP5: Lake Erie Shoreline, Wanakah Member

Location Coordinates: 42.7143°N, -78.9722°W

At this location, we will be examining the Wanakah Member of the Ludlowville Formation (Hamilton Group). This interval is examined in detail by Over and others (1999) near the mouth of Eighteen Mile Creek, which lies just north of this location. Their map of the stratigraphic contacts along the creek and accompanying stratigraphic section are reproduced herein (Figure4). The lowest stratigraphic member exposed at this location (and often covered by shifting talus) is a light gray, shaly limestone of the Wanakah Member which contains abundant (and often complete) *Eldredgeops* trilobite fossils. This is likely the upper "Trilobite Bed" as described by Grabau (1898), which can also be observed at the mouth of the creek. Above that are more typical shales of the Wanakah and a thin, but laterally continuous band of chocolate brown shaly limestone that is largely unfossiliferous. Above that is more typical shale and then the upper contact with the Moscow Formation (Tichenor Member). The Tichenor forms a

prominent ledge in the cliff face and numerous large blocks of limestone with its characteristic pyrite and rust-staining are strewn across the beach. This rock is used as a building stone in many local buildings, including Frank Lloyd Wright's Graycliff which sits just above the cliff. The rusted steel remnant of the stair tower, which used to provide "easy" access down to lake level, is still standing along the shoreline.

It is difficult to examine the stratigraphically higher units (Windom Member) of the cliff at this location, but I encourage you to use the directions below and join us for Philip Stokes and Holly Schreiber's guided tour of the Penn Dixie Fossil Park & Nature Reserve in the afternoon where they will examine these units in detail.

"END" OF TRIP: Use directions below to Penn Dixie Fossil Park for the Afternoon trip led by Stokes & Schreiber

Distances in miles		
Cumulative	Point-to-Point	Route Description
26.4	0.0	Follow Learmont / Old Manor Dr back to the entrance to the private community
26.6	0.2	Turn left onto Old Lake Shore Rd which parallels the lakeshore
26.8	0.2	POI: Just before the bridge over Eighteen Mile Creek, there is a boat launch on the right with easy access to creek level
29.7	2.9	Make a gentle left onto Rt5 Lakeshore Rd and continue NE along the lake
33.5	3.8	Make a hard right onto Big Tree / New Big Tree Rd (at the Hamburg Clock Tower)
33.6	0.1	Continue straight through the intersection (stoplight) with Francis Dr
34.8	1.2	Continue straight on Big Tree Rd where Bayview Rd veers slightly to right
35.2	0.4	Turn left on Bristol Rd just before Fire Station (small blue Penn Dixie sign)
35.4	0.2	Right left onto North St and follow signs to Penn Dixie entrance
35.5	0.1	**AFTERNOON TRIP:** Penn Dixie Fossil Park & Nature Preserve

BEGIN AFTERNOON TRIP at Penn Dixie Fossil Park & Nature Reserve (led by Stokes & Schreiber)
4050 North St, Blasdell, NY 14219 https://penndixie.org #1 Fossil Park in the U.S.!
Location Coordinates: 42.7765°N, -78.8307°W

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