A6: EXPLORING THE SURFICIAL GEOLOGY AND HYDROLOGY OF ALFRED NY

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INTRODUCTION

Alfred is located in west-central New York within the Allegheny Plateau. This area is fairly close to the outer limit of glaciation, with moraines of the Last Glacial Maximum (LGM) only 43 km to the southwest (Figure 1). Nonetheless, the landscape of the Alfred area has been significantly affected by geomorphic processes associated with the Laurentide Ice Sheet (LIS) during the Quaternary (2.58 Ma to the present). These processes include localized erosion by meltwater overflowing from proglacial lakes, subglacial erosion by glacial ice, and deposition of sediment and landforms from glacial ice, meltwater streams, and in proglacial lakes. Additional landscape modification has occurred during other intervals of the Quaternary when the LIS was north of the Alfred area or entirely absent from North America.

In this field trip we will visit some of the Quaternary landforms and sedimentary deposits of the Alfred area. Although there has been a lot of research done in surrounding areas, the surficial geology and hydrology at Alfred has only seen limited reconnaissance-level work to date. Therefore, this field trip will emphasize the general picture of Quaternary landscape evolution of the glaciated Allegheny Plateau and consider how some sediments and landforms near Alfred fit within this regional context.

Background

The village of Alfred is situated between the Genesee Valley to the west and the Finger Lakes region to the northeast (Figure 1). Elevations in the area range from around 700 m (2300 feet) above sea level at the hill-tops to 350 m (1150 feet) a.s.l. in the large valley near Hornell. Canacadea Creek flows through the village and continues northeastwards to near Hornell to join the Canisteo River which, in turn, flows to the southeast to eventually join the Susquehanna River downstream of Corning. The Genesee River is separated from Alfred by a drainage divide and flows northwards to Lake Ontario.

However, in contrast to the modern rivers, the valleys of the Alfred area show an interesting arrangement (Figure 1). The valley at Hornell does not open towards the southeast; rather, it opens towards the northwest, drops 160 m (525 feet) in elevation across the Valley Heads moraine near Dansville, and merges with the Genesee Valley to continue northwards. This valley arrangement cuts through the modern drainage divide near Dansville. Furthermore, the valley southeast of Hornell becomes increasingly narrow before opening up as it nears Corning.

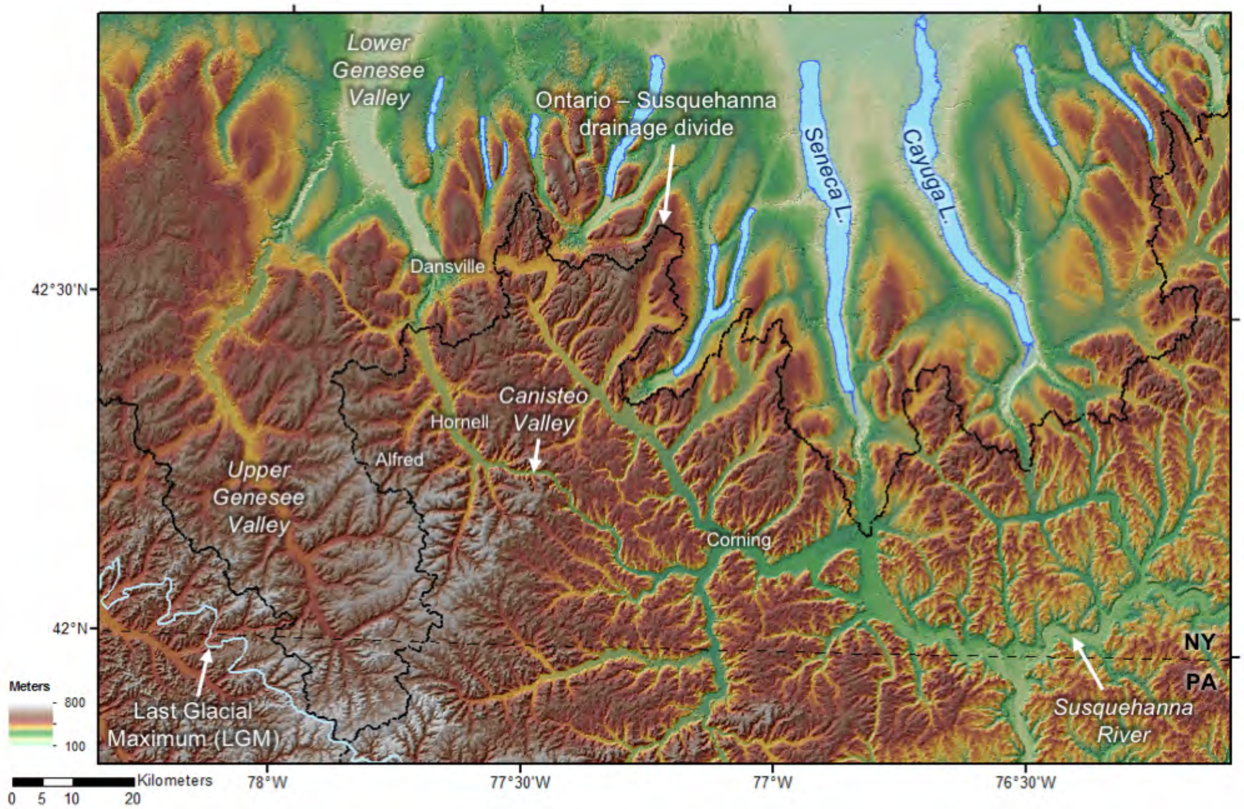

Figure 1. Shaded relief map of the Allegheny Plateau in west-central New York and Pennsylvania.

This curious mismatch of rivers and valleys in the Allegheny Plateau of New York has been the subject of numerous papers over the past century. Notable early contributions by Carney (1903), Tarr (1905), and Fairchild (1925, 1934, 1935) were based largely on inferences from topographic maps and field observations, and introduced many important ideas regarding development of major landscape features. Coates (1974) and Coates and Kirkland (1974) built on this early work and used similar methods to subdivide the Allegheny Plateau into distinct sub-regions as well as to propose a model for drainage divide incision by forced overflow from proglacial lakes.

More recent work has added critical details to understanding of the Quaternary history of this region. Radiocarbon ages tied to stratigraphic and/or paleoenvironmental analyses by Young and Burr (2006), Karrow et al. (2009), and Karig and Miller (2013) have provided chronologic control for some key pre-LGM sites in the lower Genesee Valley and around Cayuga Lake. Detailed mapping of surficial deposits by Muller et al. (1988) produced a chronology of proglacial lakes for the Genesee Valley. Seismic investigations of the stratigraphic fill of the Finger Lakes by Mullins and Hinchey (1989) and Mullins et al. (1996) revealed the subglacial erosion and deglacial stratigraphy of these deeply scoured bedrock basins. Ice flow models at both a regional (Ridky and Bindschadler, 1990) and continental (e.g. Hughes et al., 1985) scale have provided insight into the mode of ice sheet flow through the region. Regional scale modelling has also shown the time-varying pattern of glacio-isostatic rebound in the area (Lewis et al., 2005). And ongoing studies in the eastern Finger Lakes (Kozlowski and Graham, 2014) are using new dating methods (such as optically stimulated luminescence) and newly available LiDAR-based high resolution digital elevation models to further advance the understanding of these landscapes.

QUATERNARY EVOLUTION OF THE ALLEGHENY PLATEAU

These many studies provide the basis for a synthesis of the geomorphic processes that have shaped the Allegheny Plateau during the Quaternary. This synthesis is not presented here as a strict historical sequence because the details of many events remain unclear. Rather, it is intended to convey some key ideas and to facilitate interpretation of the landforms and sediments that will be seen on this field trip.

Original valley network

The original valley network of the Allegheny Plateau is pre-Quaternary in age and fluvial in origin. This drainage pattern is largely dendritic (Figure 1) and continues south of New York and Pennsylvania in the unglaciated regions of the Appalachian Plateau. It appears likely that at the start of the Quaternary the ancestral Susquehanna River drained northwards along the axis of the modern Seneca basin and that regionally the drainage divide between the Ontario and Susquehanna basins was farther south than it is today (Fairchild, 1925, 1935). Drainage divides within the plateau separated rivers that drained north from rivers that drained south (Figure 2).

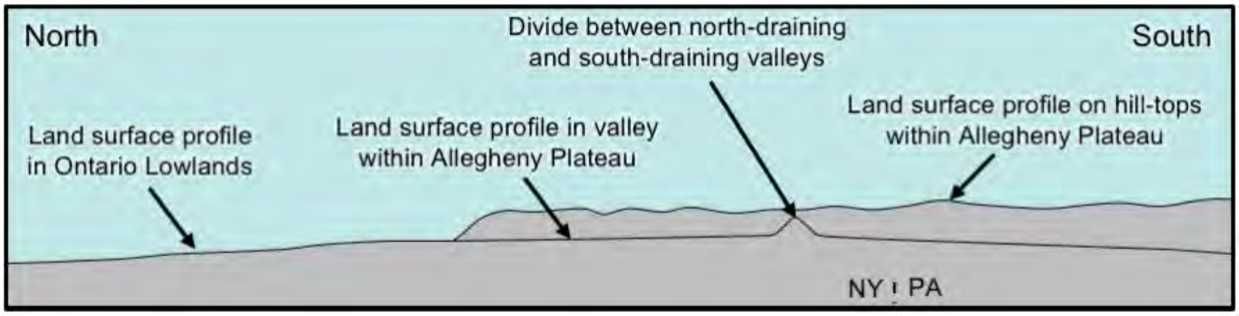

Figure 2. Schematic diagram of the northern Allegheny Plateau from Lake Ontario (left) to the LGM moraines in Pennsylvania (right). Topography is simplified from a north-south profile from Rochester NY to Galeton PA from a 10-m digital elevation model. Vertical exaggeration (VE) is 40x.

Proglacial lakes and sluiceways

Advance of the Laurentide Ice Sheet (LIS) to the northern edge of the Allegheny Plateau dammed proglacial lakes in north-draining valleys (Figure 3). Initially these lakes had low elevations as ponded water escaped through outlets along the plateau front to the west or east. However, with further advance of the ice margin these lakes were increasingly confined to valleys within the plateau and water levels were forced to rise to higher outlets draining south through the plateau.

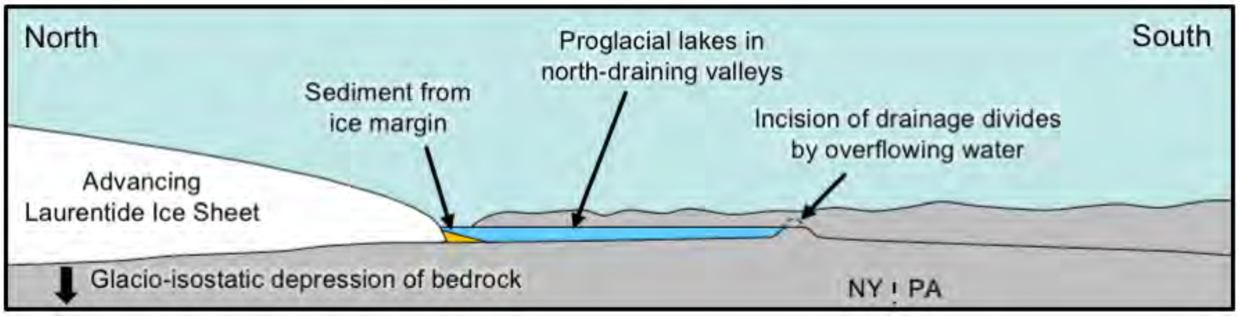

Figure 3. Schematic diagram showing the major landscape effects of advance of the LIS. Ice sheet profile assumes a basal shear stress of 100 kPa. VE is 40x.

These lake outlets would have begun as the lowest available points on the bounding drainage divides. With sustained overflow the water incised the divides and so changed the overflow points from small notches to wider, longer and lower sluiceways (Coates and Kirkland, 1974). Modern glaciers typically advance at meters per year to a few tens of meters per year and so, assuming similar advance rates and given the length of the valleys, these proglacial lakes would have likely existed for thousands of years while the LIS advanced southwards. Stillstands of the ice margin or retreats with re-advances would have extended this time for overflow incision even more. Thus, these sluiceways related to LIS advance are the result of sustained fluvial erosion over millennia rather than brief catastrophic flows.

The advancing LIS would have been a source of sediment such as clays and silts in the lakes, outwash in free-draining valleys, and till and other ice-contact sediments close to the ice margin. Although most of this sediment was eroded away during subsequent glacial over-riding, some survived in areas protected from glacial erosion. This is evidenced by the sediment sequences preserved in sections of many gorges throughout western and central New York (e.g. Von Engeln, 1931).

Glacial erosion

Subglacial erosion by the Laurentide Ice Sheet during the Quaternary has overprinted the original fluvial valley network. This erosion has been greatest in the central Finger Lakes area where the uplands between Seneca and Cayuga lakes have been substantially lowered and smoothed (Figure 1) and diminishes towards the glacial limit in Pennsylvania where the thickness and duration of ice cover was least (Figure 4) and the bedrock is generally more erosion-resistant. Erosion was also more intense at the north edge of the plateau and along the axes of the eleven finger lakes where in some cases the bedrock surface has been eroded close to or below sea level, with the bedrock bottom of Seneca Lake being the deepest at 306 m (1004 feet) below sea level (Mullins et al., 1996).

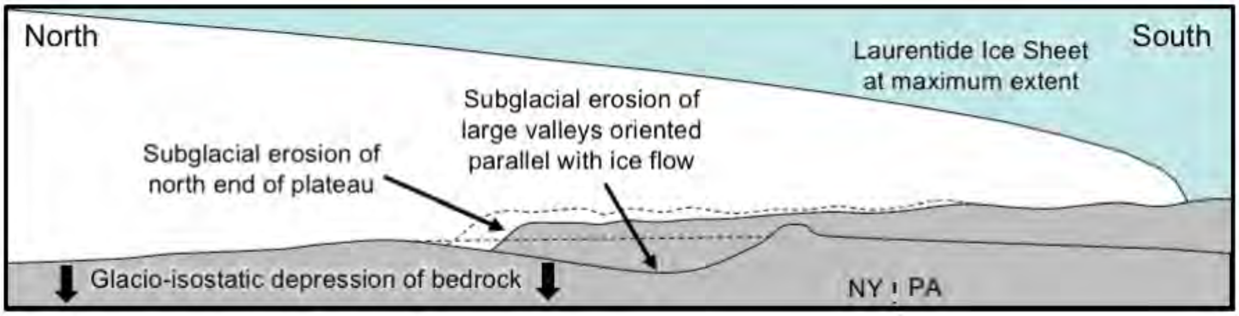

Figure 4. Schematic diagram showing the major landscape effects of the LIS while at its maximum extent. Ice sheet profile assumes a basal shear stress of 100 kPa. VE is 40x.

However, subglacial erosion was also locally selective. Sites dated to the last interglacial (c. 120 ka; Karrow et al., 2009) and the Middle Wisconsinan (c. 35 ka; Young and Burr, 2006; Karig and Miller, 2013) survived several thousand years beneath the LIS during the LGM without being eroded away. Although ice sheets can be very effective at eroding bedrock, such erosion will only happen if conditions at the base of the ice are locally favorable for erosion to occur.

The weight of the LIS also caused glacio-isostatic depression of the land surface (Lewis et al., 2005). This process would have begun to affect the area as the ice approached from the north (Figure 3) and would have continued and affected more of the area during glacial maxima (Figure 4). Total glacio-isostatic depression was greatest in the north of the region where the LIS was thickest and remained the longest.

Deglacial sediments and landforms

Sediments and landforms deposited during deglaciation are preserved at the land surface into the subsequent interglacial or ice-free interval. These include till deposits across upland areas, glacifluvial sand and gravel (outwash) in free-draining valleys, and glacilacustrine silts and clays in proglacial lake basins. These proglacial lakes (Figure 5) formed wherever drainage was blocked by the retreating ice margin and evolved from isolated high-elevation lakes into larger and lower lakes as the LIS uncovered interconnected valleys.

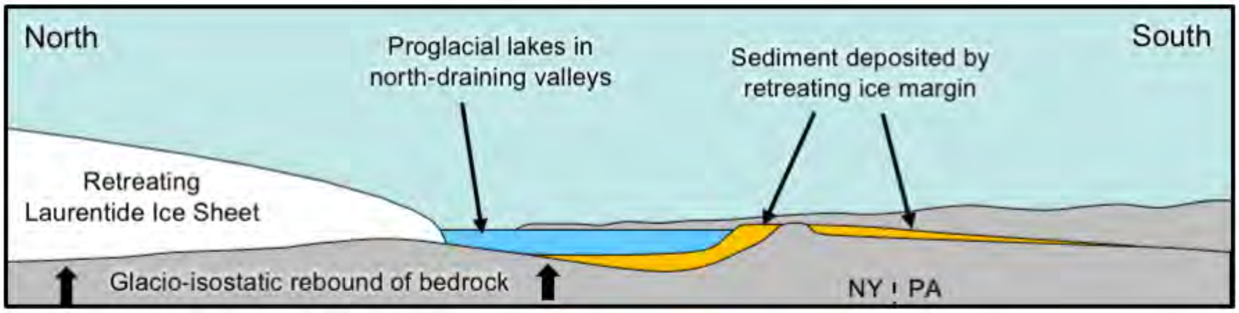

Figure 5. Schematic diagram showing the major landscape effects during deglaciation. VE is 40x.

Many outlets of these proglacial lakes during deglaciation were the same cols and sluiceways that were incised during LIS advance. Sediments deposited during advance or glacial maxima were flushed out and further incision occurred. Pulses of water from the merging of proglacial lakes caused some outflows to be briefly catastrophic and so capable of rapid outlet scouring. In addition, new lake outlet channels formed through morainal dams (e.g the Burns Outlet near Dansville) and many rivers cut new channel segments instead of re-occupying parts of their old paths (e.g. Letchworth Gorge on the Genesee River).

Deposition during deglaciation resulted in thick sediment fills in the over-deepened basins of the Finger Lakes. Seneca Lake, with a maximum sediment thickness of 270 m (885 feet), is the thickest and several others also exceed 200 meters of material (Mullins et al., 1996). Sediment also accumulated in thick deposits along the axes of large valleys throughout the Allegheny Plateau (Figure 1). Most of these valley fill deposits are capped by outwash that is graded to the Valley Heads Moraine, which today forms the modern drainage divide at the head of each large valley from Dansville to the eastern Finger Lakes.

Interglacials and other ice-free intervals

The rate of landscape change in the Allegheny Plateau is generally slower during cold or cool intervals when the LIS margin is north of the Ontario Lowlands or during interglacials when the LIS is reduced to remnant ice caps in the Arctic or completely absent. However, the formation of interglacial gorges is an exception. These developed in tributary side valleys near where larger valleys were substantially deepened during glaciation (i.e. in side valleys to the finger lakes or near drainage divides that were lowered by fluvial incision). The drop in base level in the larger valley caused headward erosion to progress upstream in the side valley, resulting in a knickpoint (i.e. bedrock-capped waterfall or cascade) at the head of erosion with a narrow gorge downstream (Figure 6).

Larger river channels, once established during deglaciation, will tend to remain in the same general location and slowly migrate through floodplain deposits. Landslides occur most often during deglaciation and become less frequent thereafter as the most unstable deposits have already failed and as the landscape becomes vegetated. Glacio-isostatic rebound, which began during deglaciation (Figure 5), also continues at a declining rate during interglacials (Figure 6).

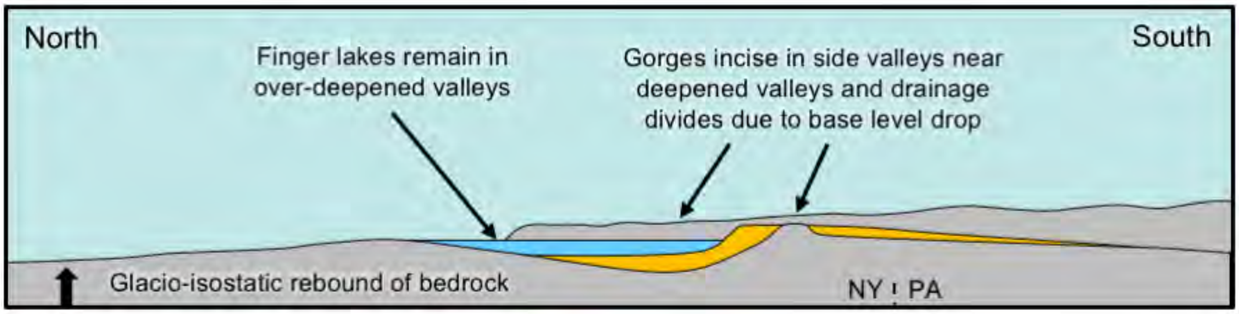

Figure 6. Schematic diagram showing the landscape during an interglacial or ice-free interval. VE is 40x.

Multiple glacial-interglacial cycles

Sediments and landforms show that the LIS has advanced into Pennsylvania at least four times during the Quaternary (Braun, 2004; Figure 7). This means that the concomitant effects on the landscape of the Allegheny Plateau from advance and retreat of the ice sheet (Figures 3-6) have also occurred at least four times. Furthermore, there may have been additional times when the LIS extended into the northern edge of the Allegheny Plateau without completely extending to Pennsylvania. Although deposits from the most recent glacial maximum and deglaciation dominate the surface and near surface sedimentary record, it is important to consider the multiple glacial-interglacial cycles of the Quaternary when interpreting landscape evolution of this region. Many deposits and landforms from prior to the LGM may currently remain unrecognized in the Allegheny Plateau.

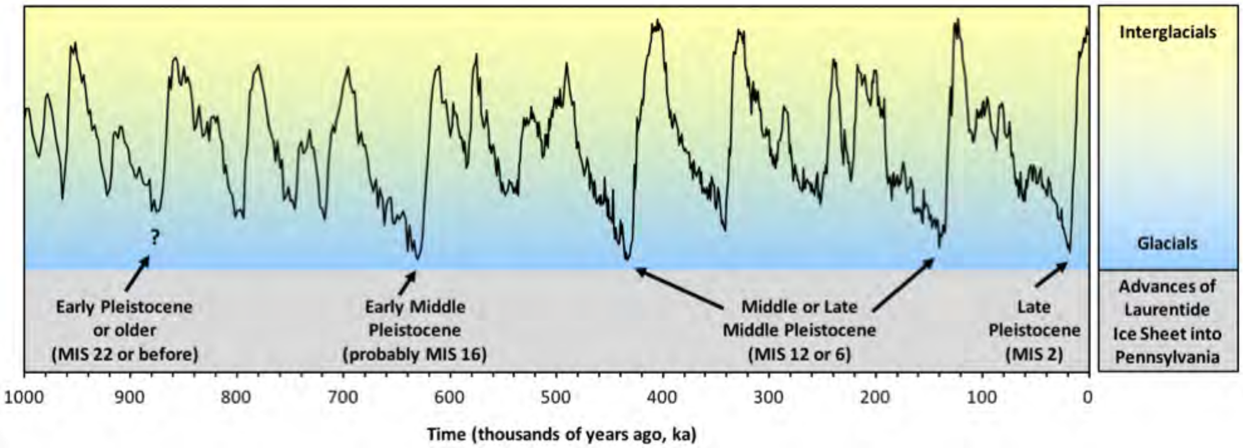

Figure 7. Deep sea oxygen isotope record, a proxy for global ice volume, with dates of LIS advances into Pennsylvania. Isotope data from Lisieki and Raymo (2005) and PA glacial data from Braun (2004).

The cumulative effect of multiple advances of the LIS through the Allegheny Plateau has been a reorganization of regional drainage. At the start of the Quaternary the Susquehanna River likely flowed north through the Seneca basin. However, incision of a pre-glacial drainage divide in northern Pennsylvania together with valley blocking glacial deposits at the south end of Seneca Lake have permanently rerouted the Susquehanna southwards. On a regional scale the drainage divide between the Susquehanna and Ontario basins has shifted northwards and, near the upper Genesee Valley, has moved westwards to leave Hornell and Alfred in the headwaters of the modern Susquehanna River.

LANDFORMS OF THE ALFRED AREA

This field trip starts at Alfred University and will follow a clockwise loop around the surrounding area (Figures 8 and 9). The route starts with sites in the Village of Alfred (stops 1-2), ascends to the uplands immediately west of the village (stops 3-4), descends the valley of McHenry Valley Creek (stops 5-7), and continues down to the western edge of the Canisteo Valley (stops 8-9). The latter part of the trip passes through Hornell to the headwaters of Bennetts Creek (stop 10) before returning to finish in the Alfred area (stops 11-12). Time will vary at each stop and we will complete as many stops as we can!

Research on the specific landforms of the Alfred area remains at a somewhat preliminary stage. Accordingly, we intend this field trip to enable participants to examine some of the most interesting features and to provide a forum for interpretation and discussion. The following pages provide some diagrams and text that we will use to during the trip to present some of the options for interpretation; please keep in mind that these are simplified and/or hypothetical and/or tentative and are not intended to be viewed as finalized explanations.

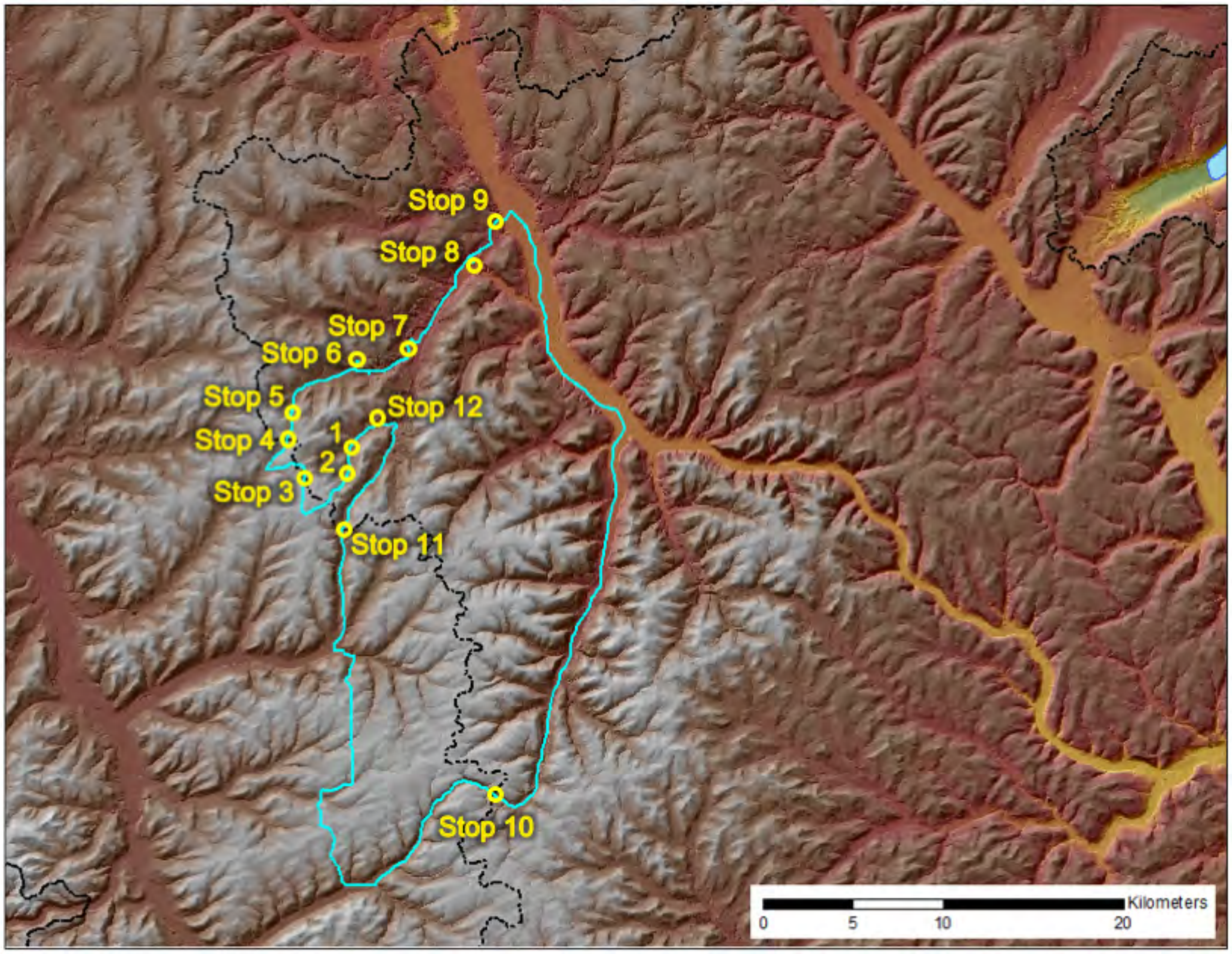

Figure 8. Field trip route. The trip begins and ends at Alfred, NY

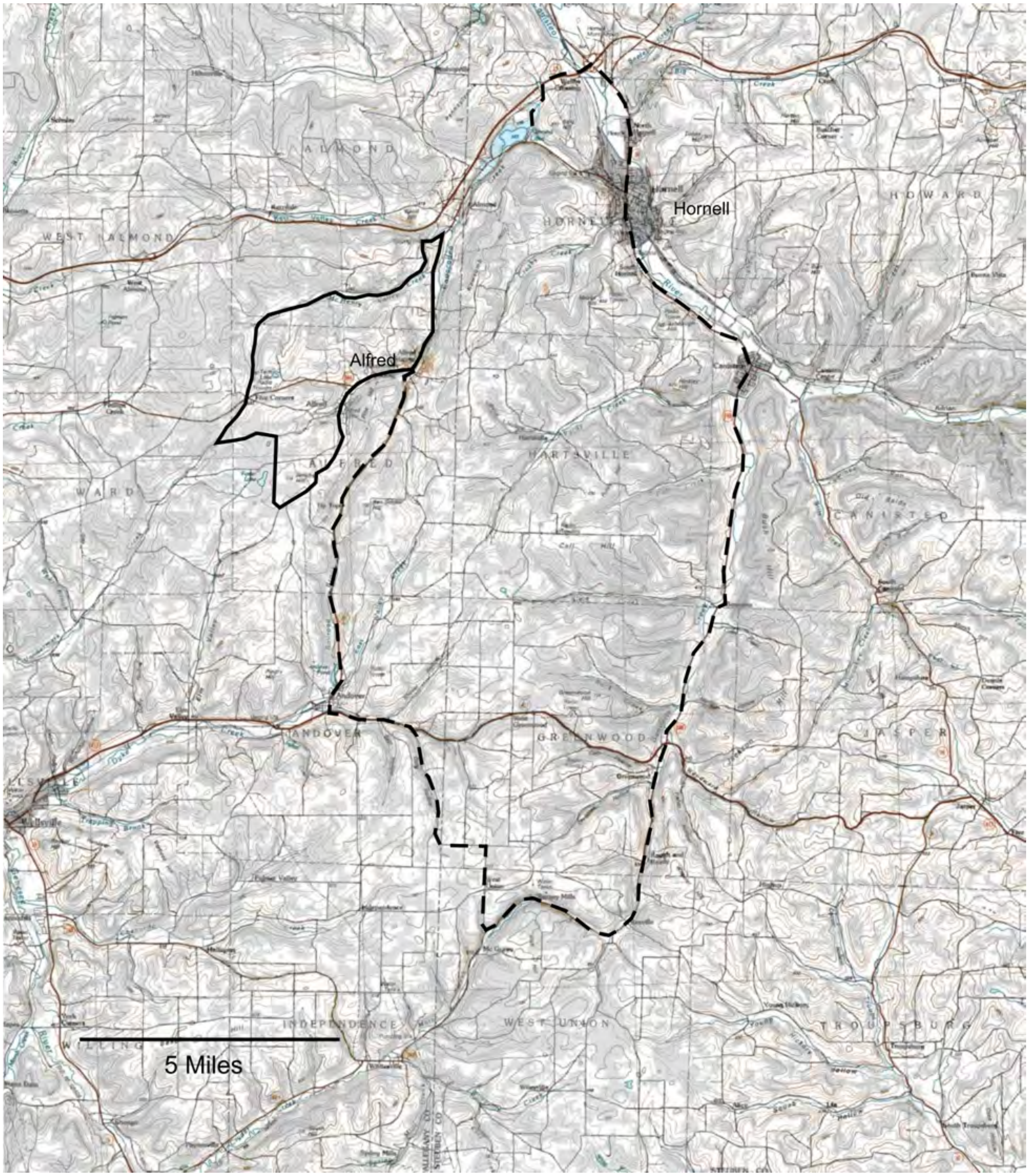

Figure 9. Field trip route, showing contours, rivers, roads, and settlements.

Col development

We have three long linear valleys occupying former cols separating the Genesee Valley from the valleys to its east: Five Corners (Stop 4), Railroad Valley at Tip Top (Stop 11), and the tail of Bennetts Creek (Stop 10). Each of these has a longitudinal profile showing the highest elevation somewhat down the valley. Figure 10 shows the actual topographic profile in Railroad Valley, and Figure 11 provides a model to explain how this profile and valley may have developed.

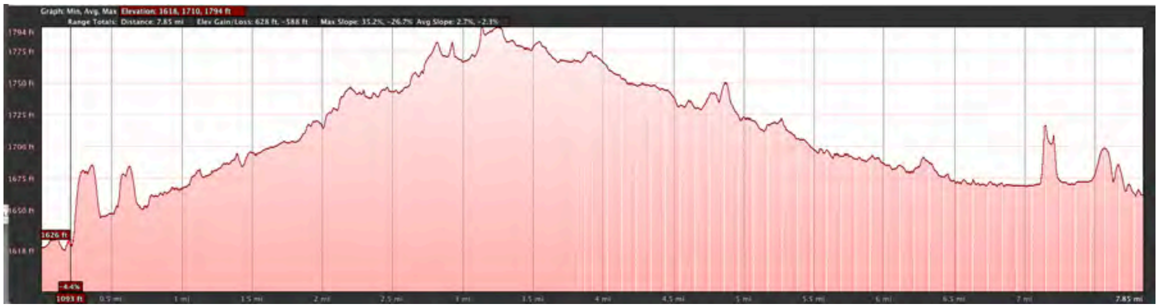

Figure 10. Topographic profile through Railroad Valley (Tip Top outlet). Profile is along the railroad track, with north (Alfred Station) to the left and south (Andover) to the right. Former lake was on the left side, where the slope is greatest and base level lowest.

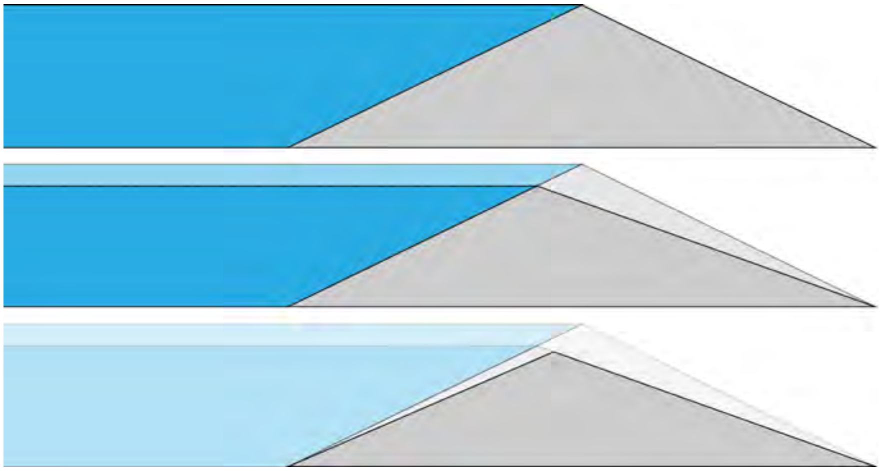

Figure 11. Model for col development.

Here is a model (Figure 11) to try and explain this:

- Top picture shows hill as it was before the lake. Slopes on both sides are equal, erosion would lower both sides at the same rate, divide would remain at the same place.
- Then the lake fills up to where it overflows the hill. Erosion now takes place on the side away from the lake, only. An outflow channel develops. This moves the divide towards the lake as the elevation of the col (at the bottom of the channel) moves down.
- Eventually the lake disappears. Now the side which had been towards the lake has a steeper gradient than the other side, so it will erode faster. It is still within the outflow channel, however. As this side erodes down, the divide will move in the direction away from where the lake had been.
- By the bottom picture the slopes on both sides are again the same, and one might imagine the divide to remain where it is as the channel continues to erode down.

Hypothetical ice margin reconstructions 1

These two maps (Figures 12 and 13) show hypothetical ice margins based on a valley tongue model (i.e. a lobe of ice extending southward from the main ice sheet that is confined to the local topography).

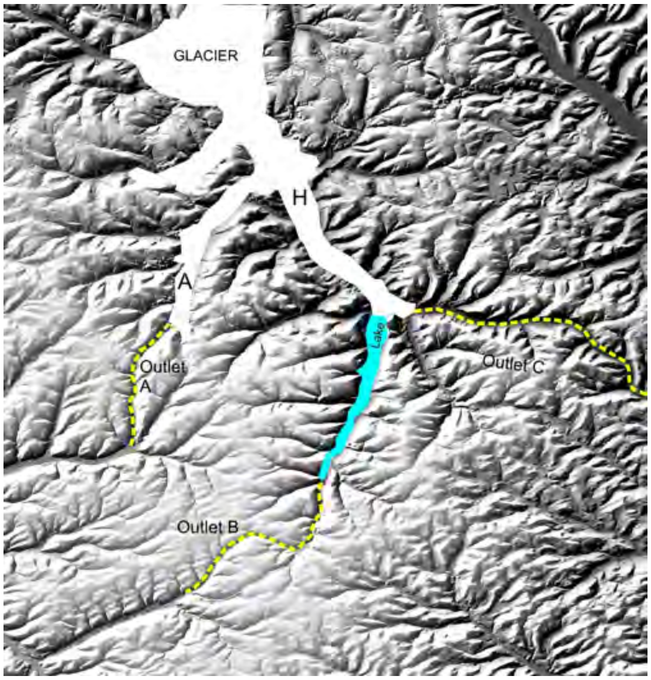

Figure 12. Hypothetical stage showing potential lobate nature of Late Wisconsin ice recession near Alfred Station (A) and Hornell (H), NY. Scale: Straight line distance from Alfred Station to Hornell (A to H) is 9.7 km (6 miles).

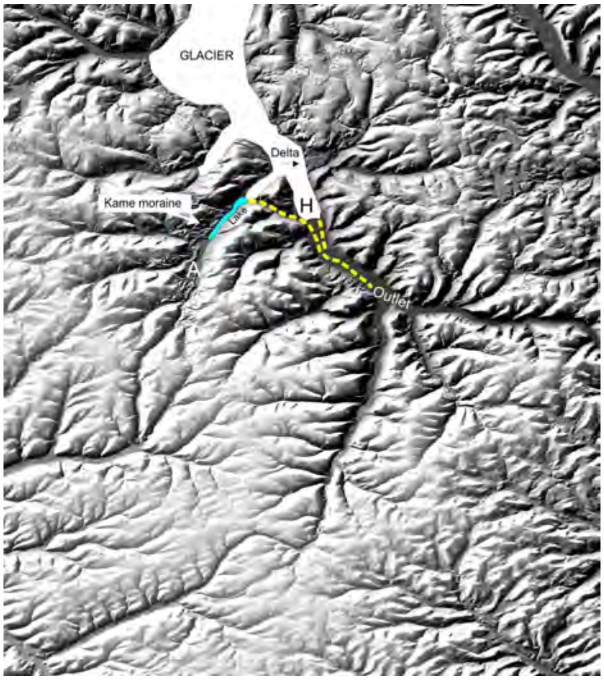

Figure 13. Hypothetical recessional ice position following earlier stage depicted in Figure 12. Scale: Straight line distance from Alfred Station to Hornell (A to H) is 9.7 km (6 miles).

Figure 12 shows a lobe of ice covering Alfred Station (A) and Hornell (H). Outlets A and B represent through-flowing meltwater discharge channels that breached local divides and joined proglacial lakes in the Upper Genesee Valley, whereas Outlet C drained southeastward toward Corning and the Chemung RIver. Lake and ice border are purely hypothetical and only are meant to be suggestive of the complexity of local conditions that might have existed during glacial recession in this area.

Figure 13 shows a subsequent stage for the same lobe of ice. Kame moraine deposits north of Alfred will be visited on field trip. Note delta abutting east side of ice depicting how depositional regimes may have varied along the ice margins, thereby producing distinctively different landforms on opposing valley walls. Outlet depicts meltwater now draining only southeastward from vicinity of Hornell to the Chemung River.

Hypothetical ice margin reconstructions 2

These two maps (Figures 14 and 15) show hypothetical ice margins for the Laurentide Ice Sheet as it receded from the Alfred (A), Hornell (H) and Canisteo (C) area.

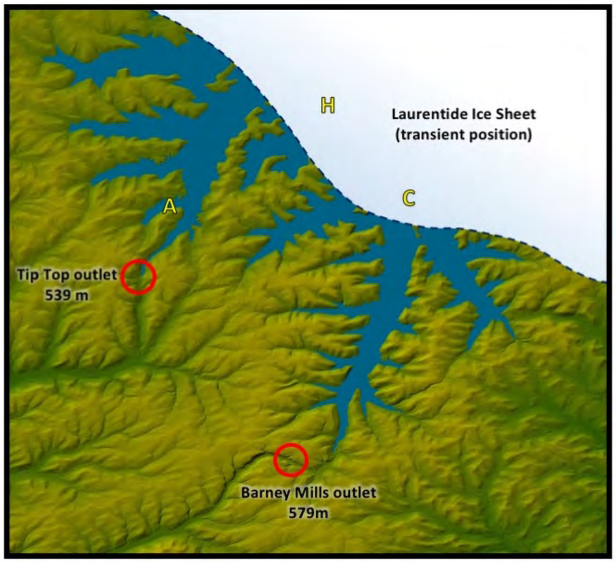

Figure 14. Transient receding ice margin impounding proglacial lakes in the Alfred area (draining through Tip Top outlet) and in Bennetts Creek valley (draining through Barney Mills outlet).

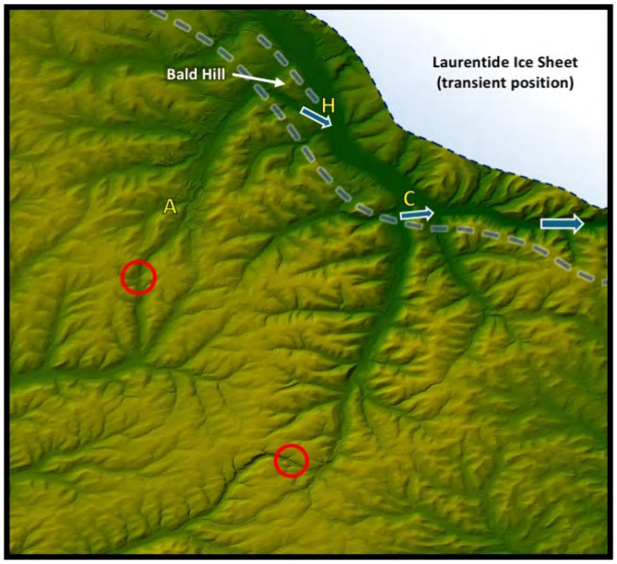

Figure 15. Further recession of the ice margin and drainage of proglacial lakes.

Figure 14 shows the Laurentide ice margin as it withdrew from the Alfred area. The general NW-to-SE trend of the margin parallels the Last Glacial Maximum (LGM) moraine farther south and the Valley Heads moraine to the north, and local topography is ignored (i.e. no attempt has been made to show ice margin lobation into valleys). Proglacial lakes in the two valleys are shown with a water surface elevation of 539 m (1768 feet) and the topography has not been adjusted for glacio-isostatic depression.

Retreat of this ice margin to Bald Hill (Figure 15) would have allowed the lake at Alfred to drain to the southeast. The floor of the sluiceway on the south side of Bald Hill is about 160-180 m (525-590 feet) lower than the Tip Top outlet and so this drainage event was very likely catastrophic. Any sediment that had been deposited in the sluiceway prior to or during the LGM was eroded out whereas sediment in another sluiceway on the west side of Bald Hill, which was protected by the ice margin, was not. This outburst flood and similar outbursts from Bennetts Creek and adjacent valleys exited the area to the southeast down the Canisteo Valley.

FIELD GUIDE AND ROAD LOG

Latitude	Longitude	Stop or View Description
42.2570	-77.7886	Walk to the new Ceramic Museum and go down to the creek where there is a strange concrete structure. Climb down into the creek and just to the north of the structure (towards the bridge) you should see a layer in the soil glistening with moisture. This is the Alfred Clay.

STOP 1. The Alfred Clay

Location Coordinates: 42.257070°, -77.788671°

Background: During the 1880's, it was discovered that the clay in the vicinity of Alfred, NY could be used to make quality terra cotta products. In 1889 the Celadon Terra Cotta Company was organized by a small group of Alfred entrepreneurs to manufacture bricks and roofing tile. The company prospered and was partially responsible for locating the New York School of Clayworking (now the New York State College of Ceramics) in Alfred. In 1906, the company was sold to the Ludowici Company of Ohio, which became the Ludowici-Celadon Company. By that time the original tile works had expanded until it covered more than an acre of ground, occupying the space where presently are located Alfred University's McLane Center and its parking lot.

The plant was completely destroyed by fire on the morning of August 26, 1909, except for the small office building which stood separately along North Main Street (and now sits at the intersection by the traffic light). While the tile factory was not rebuilt after the fire, many of its products can still be seen in town on various roof tops and on the exterior of the "Terra Cotta" building.

Observations you can make: The clays are made obvious by the water glistening on its surface. This is water which trickled down from the soil above, but hit the impermeable clay and moved along it to the stream bed. Here erosion has exposed this contact at the surface. So we see a spring at the top of the clay layer, effusing its ground water to make the clay glisten.

Dig out a bit of the clay with your finger, and note that you can roll it, mold it, make it into little sculptures. This is what artists call a "Workable Clay" and it is this property which made it valuable.

Look down the stream valley, and you will see large rocks and concrete structures, riprap, which were put in place during the reconstruction after the flood from Hurricane Agnes in 1972. Nature has disturbed many of them. This flood, which isolated Alfred for a week, caused the water to rise here to the level of the front porches of the houses across Main Street.

Other observations: In doing the foundation work for the building across the street, this clay layer was exposed. After some manipulation they put a layer of sand down on top of it, as shown below:

Figure 16. The clay layer extends from the Creek beneath the entire Ceramics Museum. Toward the right you can see it beneath the fill they put above.

Figure 17. Another view of the clay layer showing the soil above it.

Latitude	Logitude	Stop or View Description
42.2565	-77.7892	To your left, after you turn, is the Terra Cotta building referred to in the description for Stop 1. It served as a catalog for the company,

		showcasing some of their Terra Cotta tiles.
42.2548	-77.7903	The building on the east side of Main Street, Green Hall, has Terra Cotta tiles on the wall above second floor
42.2491	-77.7900	Octagon House on east, terraces on west side of the road. The houses along here were built over a century ago, and it is not likely that substantial landscape modification preceded their construction. Instead, the builders probably sought out flat spots to build on. Hence the terraces that we see here, and there are a lot of them, are probably natural. Most are separated by a foot or two difference in elevation.
42.2471	-77.7892	Downstream from this bridge are large chunks of primitive concrete which may have been part of a dam. If so, this large flat region would have been produced by the silting up of the mill pond behind the dam, and is thus anthropogenic. The terraces are visible on the right, and are at a considerably higher elevation.

STOP 2. Terraces of Lake Alfred

Location Coordinates: 42.24448, -77.78990

When the leaves are on the trees it is sometimes difficult to see the terraces which we've passed, but here there is always a clear view. The profile of the terrace is obvious, and it is dipping gently back down the valley to our north. As you continue up the hill you can view additional terraces all the way to the top, on both sides of the road.

Latitude	Longitude	Stop or View Description
42.2283	-77.8041	At the top of the hill, near the intersection with Kenyon Road, you will be at a drainage divide. The Upper Canacadea Creek watershed is behind us, and water flowing into it, towards the north, ends up in the Chesapeake Bay. Middle Dyke Creek watershed is ahead of us, and water flowing into it, towards the south, ends up in the Gulf of St. Lawrence.
42.2253	-77.8204	Shortly after turning right (west) onto Lake Road you will pass AU's Bromeley-Daggett Equestrian Center located at the Maris Cuneo Equine Park. An early director was surprised to find that many of the horse trails here, near the top of the hill, were very poorly drained.
42.2356	-77.82022	Before the intersection with Randolph Road is a turnoff to the left for AU's Foster Lake. This is a beautiful 25-acre man-made lake in a col between two hills. The lake was created by Eddy Foster in 1950 and was owned by the Foster family until 2003. Dammed at both ends, both outlets drain into the Vandermark Creek, staying within its watershed.

STOP 3. Till seen in roadside ditches

Location Coordinates: 42.24429, -77.81973

These ditches were excavated during August of 2017. Observe the angular clasts, lack of sorting, and abundant clay. Most of the clasts are sedimentary, probably derived from local bedrock.

Figure 18. Till near intersection of Lake Road and Waterwells road.

Latitude	Longitude	Stop or View Description
42.2467	-77.8249	A quarter of a mile after turning left (west) on Water Wells Road, the road reaches another high point, and drainage divide. And again, in the Upper Canacadea Creek watershed behind us, and water flows towards the north, before it turns around and ends up in the Chesapeake Bay. Whereas water in Vandermark Creek watershed ahead of us, flows towards the southwest, before it turns around and ends up in the Gulf of St. Lawrence.
42.2438	-77.8460	Make a sharp right on Vandermark Road. Proceed to the NE on this road, gaining about 60 feet in elevation as you cover 1.28 miles of road.
42.2594	-77.8321	STOP at the blinking red light at the intersection with Route 244, and when things are clear, proceed through, taking a left just beyond the intersection onto Hanneman Road, where we can park safely.

STOP 4. Five Corners

Location Coordinates: 42.259498°, -77.832163°

We are in a sizable, linear valley, having come up the Vandermark Creek and soon to go down the McHenry Valley creek - without changing direction. The valley may have formed by flow between a lake impounded at a higher elevation to the NNE, and a lake impounded in the Genesee Valley, at a lower elevation, to the SSW. This col was the lowest point between them (although originally perhaps quite a bit higher than it is now) and erosion cut it down to its current size. The processes involved, their durations and relative importance, will be discussed at this stop.

We will visit two similar valleys this afternoon.

Latitude	Longitude	Stop or View Description
42.2730	-77.8292	Cross the bridge and park at the side of the road, beyond the end of the guard rail.

STOP 5. Bridge reconstruction revealed subsurface and waterfall reveals bedrock erosion

Location Coordinates: 42.27309, -77.8292

Figure 19. Bridge in 2009, before being rebuilt.

For many years AU students measured the cross sectional areas of bridges along this road. They would often conclude that this bridge was not big enough, and they also expressed concern about how weathered the concrete was, and how erosion was undermining the wings. A StreetView image from Google Earth in 2009 shows the state of the bridge.

In the fall of 2009 major reconstruction of the bridge began. By September, when our class again visited it, much of the bridge was gone, and we got to see the material beneath the road, as shown in the figure below:

Figure 20. Subsurface beneath road a bridge under reconstruction. Area in highlighted rectangle is enlarged to the right.

Figure 21. Small waterfalls show active downcutting.

About 150 feet north of the bridge, just northwest of the road, there is a waterfall in a small ravine running parallel to the road

With the caveat, again, that much of our terrain was modified in 1972, this waterfall is cutting down through sedimentary rock, with those layers somewhat less susceptible to weathering and erosion forming a series of caprocks holding up a series of waterfalls down this stretch of the stream.

This demonstrates active down cutting and is unlike anything we saw on the other side of the col at Five Corners.

Latitude	Longitude	Stop or View Description
42.2769	-77.8285	From Five Corners we have come down about 184 feet in 1.28 miles. This is about three times as much elevation change as we saw over an equivalent distance in the Vandermark valley.
42.2984	-77.7858	After turning left at the sign for Almond Aggregates LLC, go up the hill, turn left at the sign saying, "TO PIT"

STOP 6. Almond Aggregates LLC Quarry

Location Coordinates: 42.2984, -77.7858

One of many sand and gravel quarries in the area. Note the layering, the gigantic boulders in some layers, and at least three layers of sand near the top. They are made up of fine sand and seem to be nearly horizontal. It is possible to see them in vertical sections at different azimuths, so this is a true dip, not an apparent one.

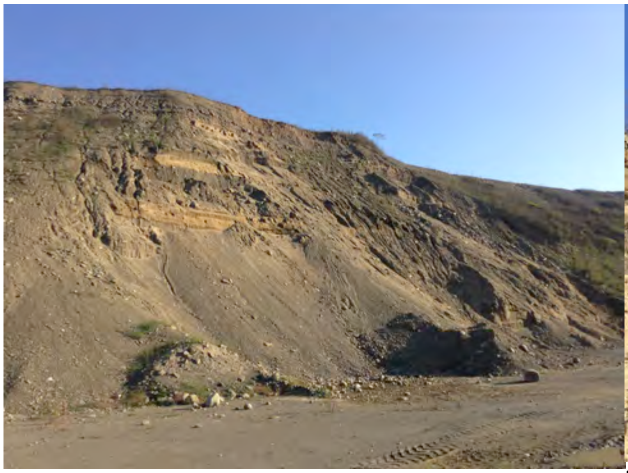

Figure 22. Quarry wall showing three sandy layers near the top.

Figure 23. Closer view of the top sandy layer from Figure 22, and boulder layer below it.

The upper levels top out at about 564 m (1850 feet) elevation. The highway beneath the quarry is at 482 m (1580 feet) suggesting a lake on the order of 82 m (270 feet) deep. The elevation of Five Corners is 631 m (2070 feet). One possibility is that the sand was deposited here before the lake had reached the Five Corners outlet elevation. Another possibility is that this deposit formed when there was a lower outlet somewhere to the NE. A third possibility is that this was formed very close to the ice front, and that various tongues of ice dammed up the lake.

There is some bedding which has steep apparent dips, and other sandy units with curious wave shaped features in some vertical sections.

That the majority of cobbles are well rounded, and there is less clay than we saw in the roadside ditches indicate that this is a fluvial deposit, perhaps a kame or kame delta.


Figure 24. Quarry wall showing steep apparent dips

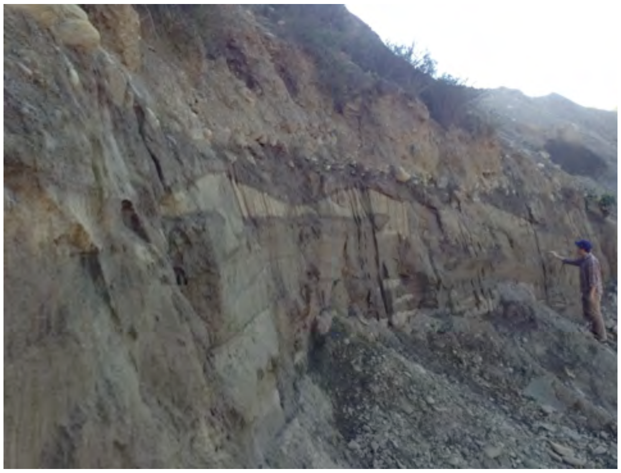
Figure 25. Wavy features in a vertical section.

STOP 7. Breached Dam (Park in road maintenance lot, to right, just before big bridge)


Figure 26. Old bridge, which served as a dam after debris lodged against it in 1984.

Location Coordinates: 42.2984, -77.7858

The higher elevations here (442 m, 1450 ft) sit on sands. We parked at about 427 m (1400 ft) suggesting that the lake responsible for those sands was about 15 m (50 feet) deep.

Beneath those sands are glacial deposits. The lake stretched up the valley we have just come down, and was prevented from draining to the north by this glacial deposit or the ice margin blocking its way. Eventually the lake broke through the dam, but the point where it did that was above bedrock, not this nice, easily eroded, glacial stuff. Still, that's where the breach was, so that is where the erosion occurred. The result is the chasm moving off to our west.

In 1984 thunderstorms brought a lot of debris down this valley, and much of it lodged against the dinky bridge, Figure 26, which was here, thus producing another dam and flooding many of the families living upstream.

STOP 8. Kanakadea Park (LUNCH)

Location Coordinates: 42.35029, -77.71071

We will take a short walk into an "old growth" forest. This has likely survived because the topography was judged too steep to farm on successfully.

The dam was built after a disastrous flood in 1935. It survived the 1972 flood, and has been used several times since then to store storm waters

STOP 9. Valley overlook at Hornell

Location Coordinates: 42.37088, -77.69656

From the vantage point of this hill, we can decipher some of the glacial history of the large valley at Hornell. Note the delta stretching towards us in the distance, and let your eye follow that elevation to the left (north). You may see homes and barns at about that elevation, suggesting a terrace there. This elevation is about 427 m (1400 feet), the same elevation that we parked at on our last stop before lunch. It isn't unreasonable to consider this the approximate base level for McHenry Valley creek. If this is true, then perhaps the breach in the dam there occurred while this delta was being formed.

Note, also, that the top of the delta is smooth, whereas similar elevations on this side of the valley are hummocky. An explanation for this might be that the delta was formed by water borne sediments, not containing any ice. This side seems to be a glacial deposit, perhaps containing chunks of ice the size of a large barn, buried at depths where they would melt only slowly. The waves of the lake originally planed off the surface on this side, so it was quite like that on the other side, but later, as that ice melted, the surface collapsed in producing all of these kettle holes.

Latitude	Longitude	Stop or View Description
42.3561	-77.6691	Bald Hill, to our right (west) is an umlaufberg, which is defined by Coates (1974) as an outlier of bedrock surrounded by (usually) glacifluvial deposits. These landforms are widespread in the glaciated Allegheny Plateau and are due to erosion from glacially forced drainage that separated the bedrock hill from the adjacent upland, and then subsequent outwash deposition around the base.
42.2780	-77.61035	Levees built after flood of 1935, rebuilt after 1972
42.2594	-77.8321	More levees and the bridge over Purdy Creek
4.2.0791	-77.6714	Road curves to the right (W) to enter the outlet valley.
42.0852	-77.6858	Watershed Boundary: Water behind us flows ESE then N in Bennetts Creek, then SE in the Canisteo River to end up in the Chesapeake Bay. Water ahead of us flows WNW before turning SW in Marsh Creek and Cryder Creek, then N in the Genesee before ending up in the Gulf of St. Lawrence.

STOP 10. Barney Mills Outlet Valley

Location Coordinates: 42.088650, -77.69327

We are in a deep valley, running about N 60 W, or WNW, and just to our south is what appears to be an incised meander. This is one of the higher cols draining to the west into the Genesee valley, at 579 m (1900 feet).

Latitude	Longitude	Stop or View Description
42.0377	-77.7628	Whitesville: Marsh Creek enters Cryder Creek
42.2151	-77.79335	Watershed Boundary: From here to the north, water ends up in the Chesapeake, whereas south of here it ends up in the St. Lawrence
42.2228	-77.7895	Tip Top. We will continue up the road a bit to where there is parking.

STOP 11. Near Tip Top

Location Coordinates: 42.2228, --77.7895

Highest point in the valley between Alfred and Andover. This valley is called "Railroad Valley" and it was an important stretch of the Erie Railroad. When the Erie Canal was built, folks in the Southern Tier feared that transportation would pass them by. They successfully lobbied for the state to authorize another railroad to take the southern route between New York and Chicago. This railroad was named the Erie Railroad, and operated from 1832 to 1960. The Erie Railroad's repair shops were Hornell's biggest employer and have since morphed into Alstom. On the route from New York to Chicago, Tip Top was the highest location at 541 m (1774 feet). Climbing to here from Hornell meant rising 622 feet in 12.24 miles, one of the steepest grades in New York. In 1877 this became famous because a train carrying strike breakers was unable to get over Tip Top, as strikers had soaped a quarter mile of the track. The strikers uncoupled the passenger cars, which removed enough weight so the locomotive and mail car could continue, thus avoiding any charges of interfering with the federal government.

In terms of the hydrology and geology, note another swamp which drains from both ends, just as we saw at Five Corners and Barney Mills.

Latitude	Longitude	Stop or View Description
42.2627	-77.7607	Alfred-Atlas Sand and Gravel Pit to the right (east)

STOP 12. New Enterprise Stone & Lime Co., Inc. Pit

Location Coordinates: 42.268687°, -77.760126°

This quarry is operated by the New Enterprise Stone & Lime Co., Inc., formerly known as Buffalo Crushed Stone. The deposits here are perhaps some kind of kames. Where exposed one can often see steep apparent dips on bedding similar to what we saw at Stop 6. Sandy layers occur, and may have apparent dips that are nearly horizontal. The deposits probably stretched across Route 21 originally, and large quarry operations on the east side of that highway, operated by Buffalo Crushed Stone as well as Alfred Atlas, at one time produced immense quantities of pea gravel, used for years for Leathers Playgrounds.

Figure 27. Wall of New Enterprise Stone & Lime Co. Pit.

These deposits may have been responsible for damming up what we call Lake Alfred, and, as at Stop 6, the glacial debris dam was at the northern end of the valley. It is often assumed that the lakes in this region were contained by ice dams to the north, and it is interesting to consider the possibility that the ice may have been far away when these lakes existed.

Much of the floor of the pit is occupied with piles of products - crushed stone at different sizes and meeting different specs, or waste material. The operation takes cobbles and crushes them, spinning the clasts against the outside wall of the crusher. This will reduce softer rocks to fine particles, which are washed away with water. The harder clasts are then sorted by size.

Figure 28. One of the crushing plants at the New Enterprise Stone & Lime Co. Pit.

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