Surficial Geology and Soils of Southern Madison County, New York

Bruce W. Selleck, Colgate University, Hamilton, New York

Introduction and General Bedrock Geology:

Southern Madison County, New York lies south of the Onondaga-Helderberg Escarpment on the northern limits of the Appalachian Plateau. Local relief is approximately 600 feet, with valley floor elevations of 1100 feet in the vicinity of Hamilton, New York. The region is underlain by middle Devonian shales, siltstones and sandstones of the Hamilton Group. These fossiliferous rocks are rather poorly resistant to erosion, and surface outcrops are rare except in stream valleys and along steeply-sloping valley walls. One prominent sandstone unit in the Hamilton Group, the Chenango Sandstone, was quarried in the area as dimension stone. The older buildings on the Colgate University campus are built of Chenango Sandstone quarried on the hill south of the main campus.

Progressively older Paleozoic rock units are exposed to the north, including lower and middle Devonian limestones of the Onondaga and Helderberg Groups, the lower Devonian Oriskany Sandstone, shales, sandstones and dolostones of Silurian age, upper Ordovician shales, and lower and middle Ordovician limestones. Upper Cambrian sandstones and dolostone overly Proterozoic basement rocks in the Mohawk Valley. Lithologies representing all of these rock units can be found within the glacial drift which mantles the bedrock of southern Madison County. The dominant exotic (lithologies other than Hamilton Group) rock types in the drift are limestone, dolostone, chert, sandstone and various Proterozoic rocks of Adirondack origin.

Glaciation and Deglaciation:

Pleistocene continental glaciation profoundly affected the topography and surficial geology of the area. Pre-glacial topography, dominated by generally north-south dendritic valley systems, was altered by enlargement and reshaping of valley cross-sections, and sculpting of upland bedrock surfaces. Although no direct evidence of pre-Wisconsin glaciation is observable in the area, it is assumed that multiple advance-retreat cycles occurred. The presence of reworked clasts of cemented glacial gravels in Wisconsin-age drift may imply the presence of pre-Wisconsin glacial deposits. However, such clasts may have been generated within relatively short time periods during the last deglaciation.

Four phases within the deglaciation history can be identified:

1. Upland ice phase - No upland areas are know to have escaped glacial coverage during the Wisconsin maximum advance. Upland lodgement tills are often the only glacial deposits on upland ridges. In this region, the onset of deglaciation was characterized by thinning of the ice sheet to expose upland regions while active ice tongues occupied progressively lower elevation of the valleys.

2. Valley ice tongue phase - Active ice flow in the valleys is documented by the presence of glacial trim lines on valley walls, and deposition of ice-contact drift on valley margins. Kame terrace landforms characterize the valley walls in the region, and multiple terraces may indicate progressive lowering of the active ice surface within the valleys.

3. Fluvio-glacial outwash and stagnant ice phase - As the active ice margin retreated to a position near the present Onondaga Helderberg Escarpment, a complex period of minor advance and retreat of the ice sheet culminated with development of morainal deposits within the northern terminus of the major north-south valleys of the Appalachian Plateau. These deposits represent the so-called Valley Heads Moraine. In Madison County, these ice-margins fed major glacial streams which deposited extensive outwash blankets to the south. It is important to note that during this phase the major drainage from the ice sheet was to the south, and thus significant amounts of water and debris were transported through, and deposited in, the north-south valleys. In this area, the southern limit of the ice margin was approximately 15 kilometers north of the Village of Hamilton, at the approximate latitudes of Stockbridge Falls and Oriskany Falls.

Outwash was deposited around and above stranded stagnant ice that remained to the south of the active ice margins. Subsequent melting of these ice masses gave rise to kettle depressions and kettle lakes rimmed by steep, angle of repose slopes. Such depressions often interrupt relatively flat outwash plain surfaces.

4. Modern Drainage Phase - As the ice margin withdrew from the present Mohawk River Valley and Oneida Lake Plain, drainage through the Mohawk and Hudson Rivers was established. (These rivers would have carried much greater discharges than at present, because the St. Lawrence River Valley was still ice-covered.) An abrupt decrease in the discharge of both sediment and water in the valleys of southern Madison County was the consequence of this newly-established drainage pattern. With the onset of essential present-day discharge, major transport and deposition of fluvial-glacial sediment ended, and minor incision and terracing of outwash plain surfaces ensued.

The transition from Phase 2 to Phase 3 in the study area generally correlates with the "pre-Valley Heads" glaciation in the western Mohawk Valley (Ridge, Franzi and Muller, 1991). Valley Heads moraine deposition began approximately 15.5 ka.

Glacial Sedimentary Facies:

The surficial deposits of the study area can be broadly subdivided into sedimentary facies whose characteristics were controlled by the environments of deposition. These characteristics are briefly summarized below:

1. Lodgement Till: Surface exposures of lodgement tills are generally encountered un upland surfaces and the upper portions of valley walls. These materials were deposited beneath active ice as compact, poorly-sorted silt and clay-rich sediments. Angular, striated boulders are common, and such tills are dominated by locally-derived shale, siltstone and sandstone of the

Hamilton Group. Lodgement tills generally form thin veneers in areas of shallow bedrock on uplands, and are assumed to be present in the subsurface in lowlands. These tills have low hydraulic conductivity, and are therefore relatively poor aquifers.

2. Ablation Till: Ablation tills cover extensive areas of the uplands, and were deposited relatively passively during ice melt. These tills are often intercalated in complex fashion with fluvial-glacial deposits. Ablation tills are generally less compact and somewhat more well-sorted than lodgement till, although extreme ranges of particle size are characteristic. Locally derived lithologies dominate.

3. Ice-Contact Stratified Drift: Water-lain sands, gravels and silts deposited in contact with ice are common along lower valley walls and valley floors. These materials were deposited in subglacial, englacial, and proglacial streams within and adjacent to active ice margins, and in proximity to stagnant ice. Well-developed stratification and well-preserved primary sedimentary structures are typical, and post-depositional deformational features, such as soft-sediment folds and faults, are present. These sediments are generally moderately well-sorted, and form high-quality aquifers.

4. Fluvial-glacial outwash: Well-sorted sands and gravels deposited by braided streams are the dominated surficial material in the valley floors. Pebbles and cobbles in these deposits are well-rounded, and clast suites contain relatively high proportions of exotic lithologies. Outwash gravels are highly desirable aquifer materials, and are the source of good quality aggregate.

5. Proglacial lake and pond deposits: Proglacial lake delta deposits are often associated with ice-contact stratified and outwash facies. These deposits generally consist of well-sorted sand and gravel, with silts and clays comprising lake-bottom facies. Lake sediments are not abundant in the study area.

The thickness of the glacial sedimentary cover is highly variable in the study area. On some upland ridges and on steeper valley walls, drift may be absent or but a few meters in thickness. In the valley floor areas, thickness of the total drift cover is commonly in excess of 40 meters.

Soil Development and Surficial Geology:

Postglacial soil development in southern Madison has been controlled by the typical factors of climate, slope, drainage vegetation and parent materials. In addition, clearing and tilling of land for agricultural purposes, which began in the early 19th century, has increased erosion rates, changed vegetative cover and altered near-surface portions of soil profiles. The great majority of soils are relatively well-buffered in the subsurface because of the abundance of carbonate minerals in the parent materials. However, as will be explored on this fieldtrip, acidic surface horizons are often present in areas of coniferous forest canopy, and, locally, in organic soils of swamp and marsh origin.

Major soil orders: The dominant soils in the area are Alfisols and Inceptisols, with subordinate Entisols and Histisols. Alfisols are characterized by well-developed organic-rich surface horizons

(A-horizon) and relatively clay-rich B-horizons with significant enrichment of iron and aluminum. Inceptisols have less well-developed profile definition, and significant iron enrichment in the B-horizon is absent. Entisols, which have relatively little profile development, are found on steeper slopes, areas of erosion and on modern stream floodplains where sedimentation occurs regularly. Histisols, which represent the accumulation of plant debris in areas with permanent high water table, are found in marshy and swampy areas, and along the margins of some lakes and ponds.

Parent Materials and Soil Characteristics: The typical soils of the region can be very broadly divided in terms of parent material into those soils that developed on silt and clay rich parent materials, such as lodgement and ablation tills, and those that developed on more well-sorted sands and gravels of outwash and ice-contact stratified drift origin. The tills are typically rich in local shales and siltstones, which provide significant amounts of clay-size materials during chemical and physical weathering of larger clasts. The primary clay mineralogy of the local shales and siltstones consists of chlorite and well-crystallized illite/muscovite. These minerals represent the starting materials for the development of the clay minerals now seen in modern soil profiles.

The relatively high clay content of till parent materials leads to soils with significant subsurface accumulation of translocated clay, and hence, such soils are often poorly drained, and perched water tables are common, particularly during wet periods. The most typical representative of soils developed on till in the area is the Mardin soil series (USDA soil mapping unit). Mardin series soils are found extensively on the uplands area where lodgement till forms the underlying parent material.

Soils that developed on more well-sorted gravels and sands exhibit better drainage and significant development of clay-rich subsurface horizons which impede throughflow of water is uncommon. However, these soils have abundant clay in the B-horizon because sand and gravel-size clasts of shale and siltstone were initially present in the parent material. These clasts release clay during chemical and physical weathering, and some clay accumulates in the B-horizon. These soils do drain more quickly in the spring, and are, in general, better agricultural soils. Typical soil series developed on gravelly and sandy parent materials are the Howard, Palmyra and Chenango map units.

Soil Clay Mineralogy:

Chemical weathering processes that accompany soil formation result in the transformation of phyllosilicate minerals. In the soils of the study area, the most common clay mineral weathering sequences involve the alteration of detrital chlorite and illite/muscovite into vermiculite. Both chlorite and illite/muscovite are abundant in the C-horizon (relatively unaltered parent material) of local soils, but are progressively less abundant toward the soil surface. Chlorite transformation proceeds by oxidation and hydration of ferrous iron in the chlorite and release of magnesium into soil waters. The transformation of illite/muscovite results from removal of potassium from the mica structure, with subsequent expansion of the structure to accommodate hydrated interlayer cations.

The relative abundance of the clays vermiculite (in surface horizons), illite/muscovite and chlorite leads to the relatively high cation exchange capacity of most local soils. Base saturation of the soils is moderate to high, and pH is generally neutral to very slightly acidic, because of the buffering capacity provided by carbonate minerals in the parent material. These soils are therefore not significantly affected by acid precipitation.

REFERENCES

On this fieldtrip we will examine the relationships between glacial sedimentary facies, landforms and soil development in southern Madison County. Those participating on the trip will receive maps and areal photographs for guidance interpretation. If you are using this guide subsequent to the meeting, the following items are suggested. Some of these materials also served as bibliographic sources for this article.

1. Hamilton, N.Y. 7 1/2 min. Quadrangle

2. Hanna, W.E, (1981) "Soil Survey of Madison County" USDA/SCS/Cornell Agricultural Experiment Station; - This very useful compilation is available from the Co-operative Extension Office in Morrisville, N.Y.

3. Cadwell, D. and Muller, E. (1986) Surficial Geologic Map of New York, Finger Lakes Sheet: New York State Geological Survey, Map and Chart Series #40 - Available from the New York State Geological Survey, Albany, New York

4. Ridge, J.C., Franzi, D.A. and Muller, E.H. (1991) Late Wisconsin, Pre-Valley Heads Glaciation in the Western Mohawk Valley, Central New York and Regional Implications: Geological Society of America Bulletin, vol. 103, p. 1032-1045

ROAD LOG

Trip mileage log begins at the main traffic light in downtown Hamilton.

Cum. Miles

0.0 Traffic light at intersection of Broad, Lebanon, Payne and Madison Streets. Proceed north on Madison Street.
0.7 Bear right at intersection with Johnnycake Hill Road
1.0 Entrance to Madison Street Quarry on right.
Stop #1. (Conditions permitting) - Madison Street Quarry - This quarry is on private property.

The exposure is at the margin of a kame terrace that continues north along the valley the holds Lake Moraine. Depending on the conditions at the working face, large-scale cross-stratification can be seen, suggesting that this portion of the terrace formed as a lake delta, indicating that ponded water was present to the south. Exposures also contain highly chaotic, poorly sorted debris flow deposits.

Note the composition of the clast suite, rounding of larger clasts, and heterogeneous textures and fabrics.

Return to Madison Street, turn right from quarry entrance, proceed north.
1.4 Intersection with Airport road. Turn left (west) onto Airport Road.
1.7 **Stop #2 Valley Overlook on Airport Road**

We stop briefly here for a view to the south of the major geomorphic features of the Hamilton area. Note the obvious terraces that flank the lower valley walls, possible glacial trim lines on middle and upper valley walls, and the subdued topography of the valley floor. Note also the feeder canal in the near foreground.

Continue west on Airport Road
1.8 Intersection with Johnnycake Hill Road. Continue west on Airport Road.
2.0 Cross feeder canal from Lake Moraine
2.3 Intersection with Route 12B. Turn right (north) onto 12B.
2.8 Note prominent terrace on left.
3.7 Intersection with Woodman Pond Road. Turn left (west) onto Woodman Pond Road.
4.3 **Stop #3 Woodman Pond and Chenango Canal**

Woodman Pond is a kettle lake that was once used as the water supply of the Village of Hamilton. The village now gains water from wells within the village that are located in highly permeable outwash gravels. This supply, available as a backup, was prone to high algal/organic loads because of overwintering flocks of 1000+ Canada Geese. Note the steep, angle of repose slopes that rim portions of the pond and adjacent marshlands.

Immediately to the west is the Chenango Canal. The canal system in this area was originally developed in the late 1830's for transport of goods from Binghamton to Utica. In the Hamilton area, a system of feeder canals captured south-flowing drainage of the Chenango River, Payne Creek and Kingsley Brook and diverted that water to the north. The Chenango Canal was essentially abandoned as a transportation system in the middle part of the 19th century as railroads were constructed. Portions of the canal system are still used, however, to supply water to the New York State Barge Canal system. The old Chenango Canal at this site carries water from Payne Creek (Lake Moraine) and the Chenango River to Oriskany Creek, which supplies the Barge Canal.

Continue west on Woodman Road.
4.6 Intersection with Eaton Road. Turn left (south) onto Eaton Road.
5.0-5.3 Howard Series soils on left.
5.4 Sharp right curve crossing feeder canal from Chenango River.
6.2 Hamilton Village limits.
6.9 Intersection with Montgomery Street. Turn right (south) onto Montgomery.
7.2 Intersection with Lebanon Street. Turn right (southwest) onto Lebanon, which becomes Randallsville Road.
8.1 Crossing feeder canal from Chenango River.
9.0 **Stop #4 Randallsville Road Terraces**

Two obvious terrace levels are present in this area. Both are underlain by relatively well-sorted gravelly sand, and the material is clearly of fluvial-glacial origin. It has been proposed that the terraces represent either glacial lake deltas or kame terraces, although these may also be erosional terraces formed during late Phase 3 deglaciation.

The soils on the terraces are excellent representatives of the Palmyra series, and are very good agricultural soils. The feeder canal at this site carries water from the Chenango River to the north, skirting the Village of Hamilton, emptying into the Chenango Canal immediately north of the village.

Turn right (west) onto Armstrong Road
9.7 Crossing feeder canal and Chenango River.
10.0 Intersection with River Road. Turn right (north) onto River Road.
10.2 Intersection with Chamberlain Road. Turn left (west) onto Chamberlain. Stone house at intersection is made of Chenango Sandstone.
11.9 Intersection with Bartlett Road. Turn left (south) onto Bartlett.
12.9 Intersection with Geer Road. Turn right (west) onto Geer.
13.3 Entrance to Bewkes Center. **Stop #5 Bewkes Center**

The Bewkes Center property was a gift to Colgate from a former chair of the Board of Trustees, E. Garrett Bewkes. We will proceed to the wooded area in the vicinity of Seymour Pond to examine soil profiles in Stockbridge and Volusia series soils, and compare soil profile development in areas of deciduous and coniferous forest canopies.

Seymour Pond may be of kettle origin. However, the surrounding surficial material is ablation till. A more likely origin is the interruption of surface drainage by the configuration of ablation till deposits at the northeastern margin of the lake. The recent sediments in the lake are almost entirely of biogenic origin (diatom and algal/organic). The lake waters are well-buffered, with a pH that varies from 6.8-6.9.

Proceed east on Geer Road.

13.6 Intersection with Bartlett Road. Turn right (south) onto Bartlett.
14.3 Intersection with Reservoir Road. Proceed south on Reservoir.
15.6 Intersection with Lebanon Road. Turn left (east) onto Lebanon.
17.9 Intersection with Rodman Road. Continue east on Lebanon Road, bearing right.
20.4 Intersection with River Road. Continue east on Lebanon.
20.6 Crossing Chenango River.
21.0 Intersection with Route 12B. Turn left (north) onto Route 12B.
21.1 Intersection with Craine Lake Road. Turn left (west) onto Craine Lake.
21.7 Bear right at Y-intersection to proceed around lake.
22.1 **Stop #6 Craine Lake**

Craine Lake is an obvious kettle lake surrounded by steep, angle of repose slopes in outwash. The soils developed on the outwash surface are Palmyra series. Craine Lake waters are well-buffered, and precipitation of fine-grained calcium carbonate occurs on aquatic plants during the warm summer months.

Continue around Craine Lake and exit toward Route 12B.

23.5 Intersection with Route 12B. Turn left (north) onto Route 12B.
25.2 Cossitt Concrete Sand and Gravel Plant on left. The quarrying is developed in outwash.
26.0 Hamlet of Middleport.
26.6 Intersection with Horton Road. Turn right (east) onto Horton. This road is steep and rough.
27.5 **Stop #7 Horton Road (time permitting)**

The fields and pastures of the uplands along Horton Road are underlain by a thin veneer of lodgement till with a high percentage of local Hamilton Group lithologies characterizing the clast suite.. Typical Mardin Series soils are developed on the till. These soils are moderately good agricultural soils, but are slow to drain in spring. As we continue east on Horton Road, and onto Preston Hill Road, you will note a number of marshy areas which attest to the rather poor drainage typical of Mardin series soils.

Continue east on Horton Road to intersection with Preston Hill Road. Turn left (west) onto Preston Hill and continue west to Route 12B to return to Village of Hamilton.

End of Trip.