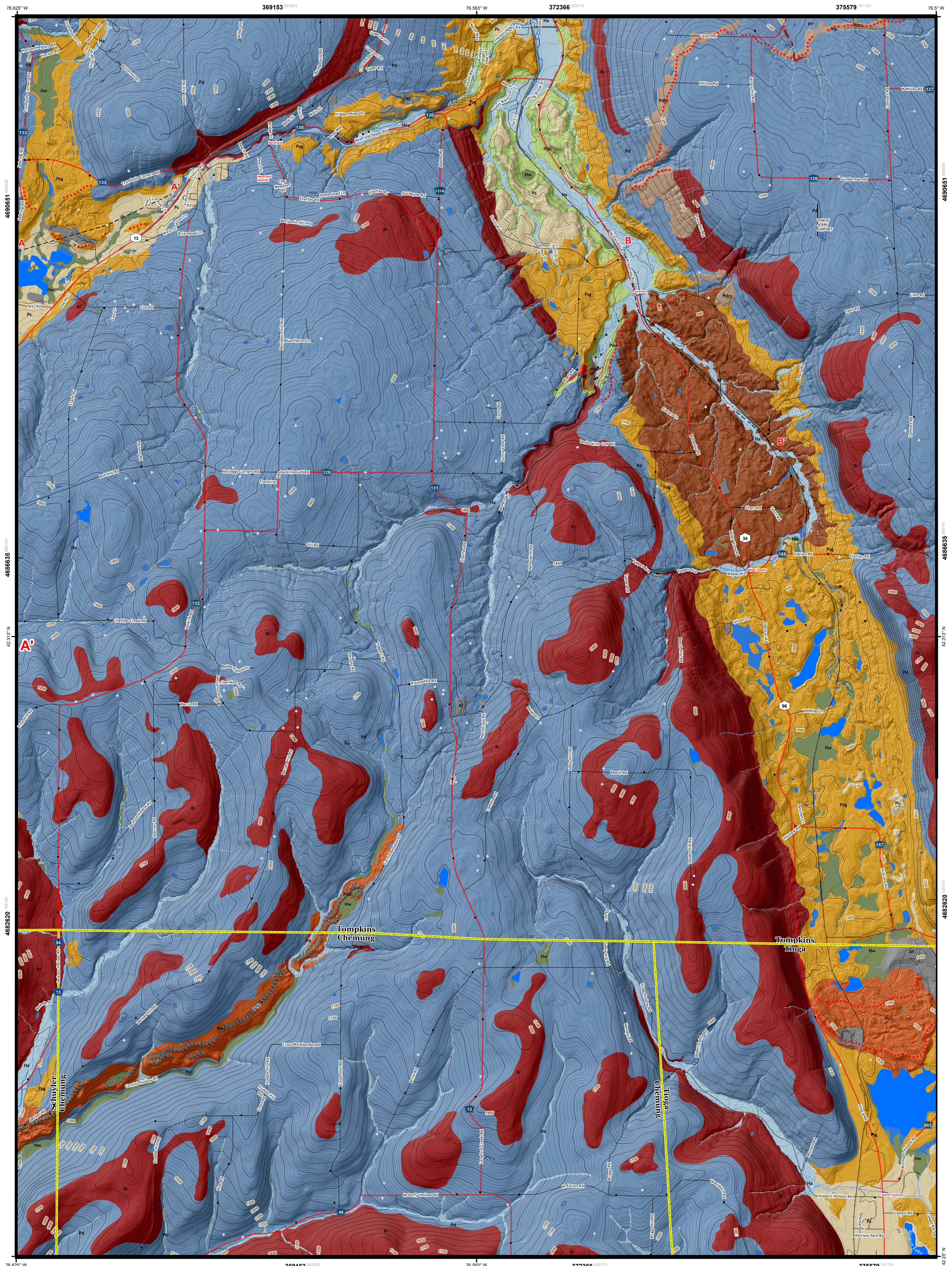
New York State Museum
Mark Schaming, Director

NYSGS New York State Museum

New York State Geological Survey



Universal Transverse Mercator, Zone 18 N
North American Datum of 1983

Hygrology, and planimetry layers from the
New York State DOT Raster Quadrangle separates for Chemung, Schuyler, Tioga and Tompkins Counties
(https://gis.ny.gov/gisdata/inventories/member.cfm?OrganizationID=108).
Geographic data layers from 2017 TIGER/Line shapes for transportation and hydrograpghy (https://www.census.gov/cgi-bin/geo/shapefiles/index.php)

Shaded relief from Central Finger Lakes 1 m,
Seneca Watershed 2m, Dean Creek 2m and NYS 10m DEM lidar data sets
(http://gis.ny.gov/elevation/index.cfm)

Magnetic declination from the NOAA online Declination Calculator:
http://www.ngdc.noaa.gov/geomag-web/#declination

SCALE 1:24,000

CONTOUR INTERVAL: 10 FEET

Geologic mapping by K. Backhaus, A. Kozlowski, J. Leone, S. Grasing and A. Alrubay, 2021.
Digital data and cartography, Karl J. Backhaus, 2021.

UTM GRID AND 2019 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SURFICIAL GEOLOGY OF THE WEST DANBY 7.5-MINUTE QUADRANGLE, CHEMUNG, SCHUYLER, TIOGA AND TOMPKINS COUNTIES, NEW YORK
Karl J. Backhaus, Andrew L. Kozlowski, James R. Leone, Sean P. Grasing and Akeed Alrubay
2021

SURFICIAL GEOLOGY OF THE WEST DANBY 7.5-MINUTE QUADRANGLE, CHEMUNG, SCHUYLER, TIOGA, AND TOMPKINS COUNTIES, NEW YORK

prepared by
Karl J. Backhaus and Andrew L. Kozlowski

Supported in part by the U.S Geological Survey Cooperative Agreement Number G20AC00418
National Cooperative Geologic Mapping Program (STATEMAP)

Introduction:
The West Danby 7.5-Minute Quadrangle was mapped as part of the 2020 National Cooperative Geologic Mapping Program funded STATEMAP project (award #G20AC00418). This quadrangle was one of twelve quadrangles to mapped as part of the Tompkins County Surficial Geologic mapping project currently being undertaken by the NYSGS starting in 2018 and concluding sometime in the early to mid-2020's. The purpose of this map was to identify and delineate various surficial and geologic materials with the intent that this information can guide municipalities in land use, environmental and natural resource decisions across its roughly 55 square mile area.

The West Danby quadrangle is located along the northeastern, southeastern, northwestern and south-central portions of Chemung, Schuyler, Tioga and Tompkins Counties, respectively. It lies within the Finger Lakes Region of New York State about 6 miles south of the City of Ithaca, New York. The Town of Newfield, Town of West Danby, and Village of North Spencer are the main municipalities within this quadrangle. This quadrangle is largely rural with small tracts of state-owned forest and private rural farmland. The Newfield and Danby State Forests are found in the western and eastern portions of the quadrangle respectively. This quadrangle is situated within the Alleghany Plateau physiographic province is generally ramping higher elevation ridges to the south of the Town of Newfield with deep valleys between them. There is roughly 1,460 feet (445 meters) of elevation change between the highest peak just west of Jackson Hollow Rd at 1,950 feet above mean sea level (594 meters-amsl) to the Cayuga Trough floor at 494 feet-amsl (150 meters-amsl). Cayuga Inlet, West Branch of the Cayuga Inlet, the Fish Kill and Spencer Lake are the major water bodies in the area along with various unnamed ponds in the Cayuga Trough.

Bedrock in the area is generally grey shales and sandstones that are Devonian in age (Rickard and Fisher, 1970). The predominant bedrock found in the quadrangle were grey to blue shales with intermittent sandstone beds. Limestones were found outcropping in two spots, but relatively thin in size. According to the Finger Lakes sheet of the Geologic Map of New York State, the bedrock in the quadrangle is comprised of the Cashaqua and Middlesex Shales, Beers Hill Shale; Grimes Siltstone, Dun Hill, Millport and Moreland Shales, Geneseo Shales and the Ithaca Formation - shale, siltstone and the Sherburne Siltstone (Rickard and Fisher, 1970).

The surficial geologic units in this quadrangle were previously mapped at 1:250,000 scale and were reported to be swamp deposits, outwash gravels, kame moraine, kame, till, thin till over rock, lacustrine silt and clays and alluvium (Muller and Cadwell, 1986). Limited mapping has been completed at a higher resolution than that of Muller and Cadwell, (1986) with the most recent concentrated on the Cayuta Inlet Valley by Miller and Pitman (2012) interpreting previous mapping efforts at 1:24,000 scale.

Methodology:
To create the surficial geology map of the West Danby quadrangle, preliminary field maps were created using the ESRI ArcMap 10.8 software and consisted of all available topographic data (roads, lidar surface terrain and hydrography) to plot all field data on including field stops, bedrock outcrops and important site information. Surficial soil sampling employed the use of a five-and-a-half-foot hand auger to allow sampling below the variably thick organic soil horizon (below the topsoil). Another tool used is an entrenching shovel and pick. This tool was used to remove topsoil and/or eroded sediments from outcrops or exposures to expose fresh sediments for analysis. At each field stop, the coordinates (latitude and longitude in decimal degrees) were taken using a Garmin GPS 66st, descriptive notes on the sediment found, whether a sample and/or a high-resolution, scaled photo were taken, and the time at which the stop was taken were logged into a field notebook (Backhaus_21).

At most of the field sampling sites, a soil sample was taken for grain-size analysis. This employee the use of either one or two processes: dry-sieve or wet-sieve analysis. These processes followed the procedure outlined by Bowles (1978), while only using a seven-tiered sieve stack (#5, #10, #18, #35, #60, #120, #230, and Pan) for both dry- (mechanical) and wet- (hydrometer) sieve analysis. The predominantly cohesive (fine-grain dominant) samples were sorted using the wet-sieve analysis, while the cohesionless (coarse-grain dominant) samples were sorted using the dry-sieve analysis.

The final surficial geologic map, cross-section and elevation maps were produced using the ESRI ArcMap and Adobe Illustrator CS6 programs. The cross-sections were created in ArcMap using the XActo Cross-section 10 tool developed by Jennifer Carell, formerly of the Illinois Geologic Survey, and then exporting the cross-section into Adobe Illustrator to connect the stratigraphic units. The surficial geologic map was created by scanning the mylar sheet (WBY_Backhaus_Mylar_21) drafted from the geologic field map. Polygons were then produced by digitizing this map in ArcMap and colored according to surficial geologic units found within the quadrangle. The final map was drafted in Adobe Illustrator and exported as a PDF file.

Results:
A total of 347 field stops were taken, with 144 samples for grain-size analysis (see Appendix), within the quadrangle. Some stops contained more than one sample as they exhibited stratigraphy either in an exposure or at depth with the hand-auger. The final count for lithologies found during field sampling was: 185 stops were diamicton, 68 were bedrock, 37 were sand and gravel, 27 were sand, 21 were glaciolacustrine sediment, three were cemented sand and gravel two were sand and cobbles, two were unknown, as they were large exposures of multiple lithologies, and two were alluvium. The surficial geologic units found within the quadrangle are as follows:

Artificial Fill (Af)
This unit is generally composed of coarse/fine, large cement mounds and/or crushed rock anthropogenically transported and used for construction purposes. This material is used in artificial dams, built to retain water, and large, raised roadbeds for bridges within the quadrangle.

Holocene Alluvium (Ha) and Holocene Wetland Deposits (Hw)
Post glacial sediments occupy the low areas or land depression throughout the quadrangle. Ha is associated with fluvial process in creek valleys throughout the quadrangle. This lithology generally consists of stratified silt, sand, and gravel. Hw is associated with low areas and depressions in the highlands of the quadrangle where wetlands form due to poor drainage. This lithology consists of peat, marl, clay or sand in these areas of poor drainage.

Pleistocene Silt and Clay (Plsc)
Stratified, fine-grained sediment consisting of fine sand, silt and clay size particles. Inferred to be deposited in mid shore to deep-water settings of glacial lakes. May include marl, rhythmites, and varves. Plsc is found within lower elevations of Virgil and Sixmile creek valleys and within a large exposure in the Ringwood Preserve along the western edge of the quadrangle.

Pleistocene Sand (Ps)
Well sorted and stratified sand, deposited by fluvial, lacustrine or eolian processes. Inferred as deposits associated with distal glacial environments. Well-sorted sand deposits were observed down-slope from deposits of coarser sand and gravel deposits (Psg), likely due to a decrease in energy during deposition.

Pleistocene Sand and Gravel (Psg)
Characterized as well-sorted and stratified sand and gravel this unit is interpreted to be deposited by glacial meltwater at or very near the glacier and can be found several meters in elevation higher than the present-day river valley floors. Psg is found in the on the near the banks of the Dryden Lake/Virgil Creek, Sixmile and East Branch Owego Creek Valleys. Psg is also found as small flat-topped terraces in smaller creek valleys, and in front of the large moraine complexes along the western edge of the quadrangle.

Cemented Sand and Gravel (Pcsg)
Poorly sorted and matrix supported in most locations. Matrix consists of well-sorted sand cemented with well-developed calcite or silicate rinds around clasts. Clasts are predominately from local Paleozoic bedrock but include exotic lithologies of granite and gneiss and range in size widely from pebble gravel to cobbles. Inferred to be subaqueous or proglacial outwash deposits.

Pleistocene Cobbles to Sand (Pics)
Stratified ice contacted deposits, variable coarse-grained sediment consisting of boulders to sand size particles. Inferred to be deposited with stagnant ice in the form of sand and gravel hummocks with the northeast and northern section of the quadrangle as kame moraine deposits.

Pleistocene Discontinuous Ice Marginal Deposits (Pdim)
Discontinuous lenses of heterogeneous sediment deposits from supraglacial, aeolian, paraglacial and modern fluvial processes in origin. Grain-sizes range from clay to boulders in size with medium to fine sand being the dominant grain sizes. Surface is hummocky while the deposits are either massive or laminated to two-inch thick beds.

Pleistocene Diamicton (Pd)
This unit is a mixture of sediment grains that range from clay to boulders in size. In this quadrangle, all diamicton is interpreted to be glacial till, sediment deposited directly beneath the glacier. It is generally matrix supported, sand-dominant, and tan and reddish brown in color. Diamicton is found throughout the quadrangle independent of elevation and underlies much of the other surficial geologic units within the quadrangle.

Pleistocene Diamicton (Clast Supported) (Pdcs)
The unit is an admixture of unsorted sediment ranging from clay to boulders. Generally, clast supported, massive and clast rich. Interpreted as till. In this quadrangle identified moraines are comprised of clast supported till ranging from gravel rich in some cases showing hummocky topography along the morainal boundary.

Summary and Conclusions:
The West Danby quadrangle lies within the south-central portion of Tompkins, northeastern Chemung, southeastern Schuyler, and northwestern Tioga Counties. The vast variation in topography in the quadrangle makes it unique in Tompkins County from the floor of the Cayuga Trough to the dissected plateaus in the south. These plateaus and valley walls of the trough are comprised of Devonian Age shales, sandstones, and limestones. Since their deposition and subsequent lithification, these vast formations have undergone periods of erosion and dissection by fluvial and glacial processes. Multiple orogenic events caused shifting, fracturing, and tilting of these formations towards the south. Evidence of these geologic events and processes occurring over million of years to the Holocene is seen across the mapping area as bedrock only outcrops at summits, in stream beds, and roads cuts. The most impressive outcropping is found along the west wall of the Cayuga Trough along Tupper Avenue in the Town of West Danby. This cut lies along a tributary stream to the Cayuga Inlet and consists of interbedded tan and grey shale and sandstones. At its tallest the outcrop is about 30 feet (9.2m) in height. This outcrop in cut to the south by another stream channel abruptly ends at a 30-foot unnamed waterfall. Atop the bedrock, the most common lithologic unit is diamicton (Pd). The diamicton is made up of mostly mottled to brown sand-dominant diamicton, matrix-supported, while the size of the gravel clasts within ranged from pea gravel to boulder in size. This lithologic unit, while widespread, can be diagnostic in showing the movement and interaction of the Ontario Lobe of the Laurentide Ice Sheet in this quadrangle based on its sediment characteristics. The diamicton found in most areas of the

Summary and Conclusions Continued....
quadrangle based on its sediment characteristics. The diamicton found in most areas of the quadrangle is indicative of lodgement tills due to their density, bimodal distribution of grains, and contained predominantly local bedrock clasts and many contain faceted clasts. A few areas within the southern Cayuga Trough were semi-cohesive, mainly unconsolidated, sand-dominant and contained coarse gravel to boulder clasts. These characteristics are diagnostic of a supraglacial till due to its proximity to the LGM margin just south of this region in the southeastern corner of the quadrangle. Along former ice-marginal position are deposits of a clast-supported and boulder rich till (Pdcs) and are indicative of a ice-marginal position, Sand and gravel deposits were abundant and found throughout this quadrangle as both fluvial deposits (Psg) and ice-contact-deposits (Pics). Throughout the Cayuga Trough and the Newfield Creek valleys, sand and gravel overlies diamicton and it stratified. These deposits consist of most medium sand with smaller percentages of coarse/fine sand and medium to coarse gravel with an occasional boulder. The ice-contact deposits contained the coarsest materials of sand and a higher percentage of gravel clasts due to their proximity to the ice margin and meltwater flows. Ice-contact deposits often were bordered by stratified medium sand (Ps) deposits or stratified sand and gravel deposits aside from the center of the Cayuga Trough in the Town of West Danby. Stratified medium sand deposits were found overlying the sand and gravel deposits throughout the quadrangle but mainly in front of former ice marginal position west of the Town of Newfield and in the Town of Spencer in the northwestern and southeastern corners of the quadrangle, respectively. This region consisted of a unique sediment lithology called the Pleistocene discontinuous ice marginal deposit. This deposit consisted of medium sand, sand and gravel, diamicton and glaciolacustrine silts and clay that were discontinuous through this area. The hummocky nature and its proximity to the LGM margin and glacial Lake Ithaca caused for the uneven distribution of sediment. The Law of Superposition and Original Horizontality does not apply to this region as the melt out of ice blocks and the entropic distribution of braided stream channel deposits changed the surface topography allow for deposits to be variable every quarter mile, even at the same elevation. Glaciolacustrine silts and clays (Plsc) were common in the Cayuga Trough as these were deposits of ancestral glacial lakes such as glacial Lake Ithaca as these lakes were formed between the moraines and the retreating icesheet. The largest deposit was found on the south side of Piper Road as a 40-foot (12.2m) outcropping of laminated to massive silt and clay deposits that is currently being eroded by the tributary creek to the Cayuga Inlet. Areas with vast deposits of glaciolacustrine silts and clays are prone to rotational failures which can be seen on the lidar hillshade. Since the deposition of these units they have undergone almost constant erosion and transportation due to fluvial or colluvial processes forming alluvial (Ha) terraces along stream and creek beds. Other areas have impounded water and formed wetlands (Hw) with kettles or former meanders in a creek. Most of these wetlands are found within the Cayuga Inlet and occupy former kettle lakes and ponds.

Glacial landforms found within this quadrangle reflect proximal deposition and erosion due to the type and sediment makeup of each landform. Of the landforms found, none were as long and apparent as the Jackson Creek Esker System, named by Gillespie (1980), in the southwestern corner of the quadrangle. This esker is 35 feet (10.7m) at its tallest and over 3.7 miles (5,900m) in length in the quadrangle alone. There are wetlands impounded within sections of this esker system as well. End and annual moraines were both found within this quadrangle, but mainly within the Cayuga Trough and along the northern border of the quadrangle. From these landforms, it can be observed that this area has evidence of at least two separate lobes off the Cayuga sub lobe of the Ontario Lobe of the Laurentide Ice Sheet. Two sub lobes terminated just west of the Town of Newfield, with one flowing from the east and one from the north. The Cayuga sub lobe terminated just north of the Town of Spencer as a push-ridge moraine. This moraine has been mined out as it is composed of ice-contact fine/medium sand to cobbles. As the three sub lobes retreated north up the Cayuga Trough, the push-ridge terminal moraine impounded Glacial Lake Ithaca depositing vast glaciolacustrine silt and clay deposits. These silts and clays overly the outwash sands and gravels deposited from meltwater flows off the tongue of the glacier. These outwash sands and gravels covered buried ice blocks, insulating them for some time until they eventually melted away, creating the hummocky surface that is seen today. While Glacial Lake Ithaca is the most well documented lake in the Cayuga Trough, there is evidence of multiple cycles of advance and retreat in the Trough until its final retreat around (XX,XXX years ago). This is especially seen in the area north of Station Road in the Town of West Danby as there are no continuous units of silts/clays and sands/gravels with most lenses being discontinuous and interbedded within one another and spots of diamicton within.

Upon completion of field mapping within the West Danby quadrangle, the evidence discovered in this area suggests that multiple glacial episodes as seen in exposures with multiple interbedded sediment layers of glaciolacustrine and outwash sediments. An OSL sample was taken in a medium sand deposit in the Town of Newfield within a faulted silty fine sand deposit above a till later WBY-21-297 will help constrain the minimum age of the deposition of the faulted sand above a diamicton layer. Further work is to be done within the Newfield Creek Valley and Cayuga Inlet Valley (Cayuga Trough) as a subsurface drilling project during the Summer of 2022 with at least two boreholes planned between the two areas. No OSL dates are currently available at the time of this report.

References:
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Rickard, L.V., and Fisher, D.W., 1970, Geologic Map of New York, Finger Lakes Sheet, New York State Museum, Map and Chart Series, No. 15.

DESCRIPTION OF MAP UNITS

Holocene

Unit	Description
Af	**Artifical Fill (Af)** Surficial sediment composed of coarse/fine and or crushed rock anthropogenically transported and used for construction purposes.
Ha	**Stratified silt, sand and gravel (Ha)** Sorted and stratified silt, sand, and gravel, deposited by rivers and streams. May include cobbles and boulders. Inferred as post-glacial alluvium and includes modern channel, over-bank and fan deposits
Hw	**Wetland Deposit (Hw)** Peat, muck, marl, silt, clay or sand deposited in association with wetland environments. Various sediments can be present at transitional boundaries from one facies to another
Hdc	**Diamict Colluvium (Hdc)** Unsorted and unstratified deposit of gravel, sand, silt, clay, with boulders/cobbles possible. Described as a mass-wasting deposit at the base of steep hillslopes and cliffs as part of a slump or hillslope failure.

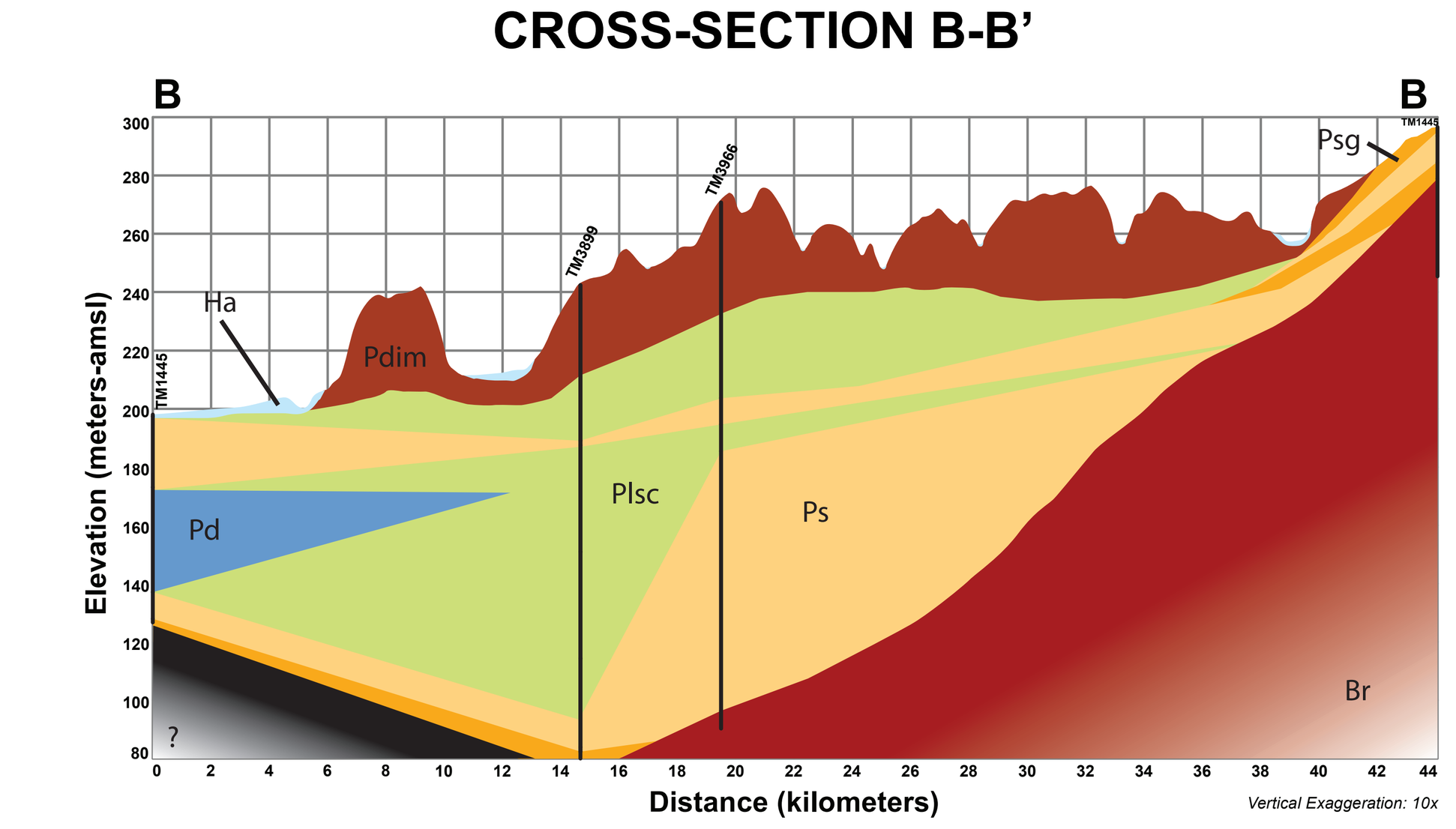
Pleistocene

Unit	Description
Plsc	**Silt and Clay (Psc)** Stratified, fine-grained sediment consisting of fine sand, silt and clay size particles. Inferred to be deposited in mid shore to deepwater settings of glacial lakes. May include marl, rythmites, and varves.
Ps	**Stratified Sand (Ps)** Well sorted and stratified sand, deposited by fluvial, lacustrine or eolian processes. Inferred as deposits associated with distal glacial environments.
Psg	**Stratified sand and gravel (Psg)** Well-sorted and stratified sand and gravel. May include cobbles and boulders. Inferred to be delta, fan or lag deposits in glacial channels or near former ice margins.
Pics	**Cobbles to Sand (Pics)** Stratified ice contacted deposits, variable coarse-grained sediment consisting of boulders to sand size particles. Inferred to be deposited along an ice-margin. May include, interbedded coarse lenses of gravel and clast supported diamictons (flow tills).
Pcsg	**Cemented Sand and Gravel (Pcsg)** Poorly sorted and matrix supported in most locations. Matrix consists of well-sorted sands cemented with well developed calcite or silicate rinds around clasts. Clasts are predominately from local Paleozoic bedrock but include exotic lithologies of granite and gneiss and range in size widely from pebble gravel to cobbles. Inferred to be subaqueous or proglacial outwash deposits.
Pdim	**Pleistocene Discontinuous Ice Marginal Deposits (Pdim)** Discontinuous lenses of hummocky heterogeneous sediment deposits from supraglacial, aeolian, paraglacial and modern fluvial processes in origin. Grain-sizes range from clay to boulders in size with medium to fine sand being the most dominant grain sizes.
Pd	**Diamicton (Pd)** An admixture of unsorted sediment ranging from clay to boulders. Generally matrix supported, massive and clast-rich.
Pdcs	**Diamicton (Pdcs)** An admixture of unsorted sediment ranging from clay to boulders. Generally clast supported, massive and clast-rich.

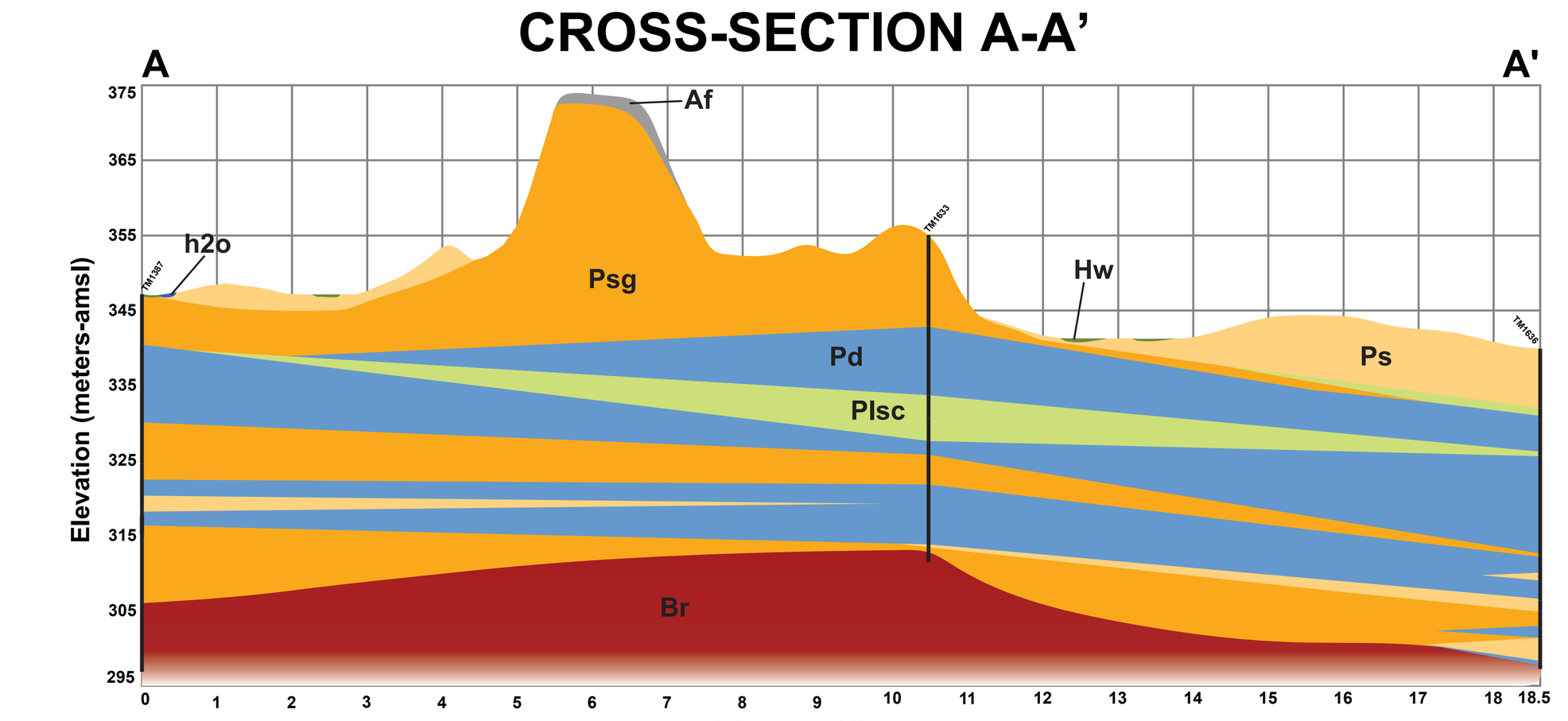
Pre-Pleistocene

Unit	Description
Br	**Bedrock (Br)** Non-glacially derived, hard rock, pre-pleistocene in age. May be covered up to a meter in diamicton, sand and gravel, or sand and clay in areas marked as Br.

CROSS-SECTION B-B'



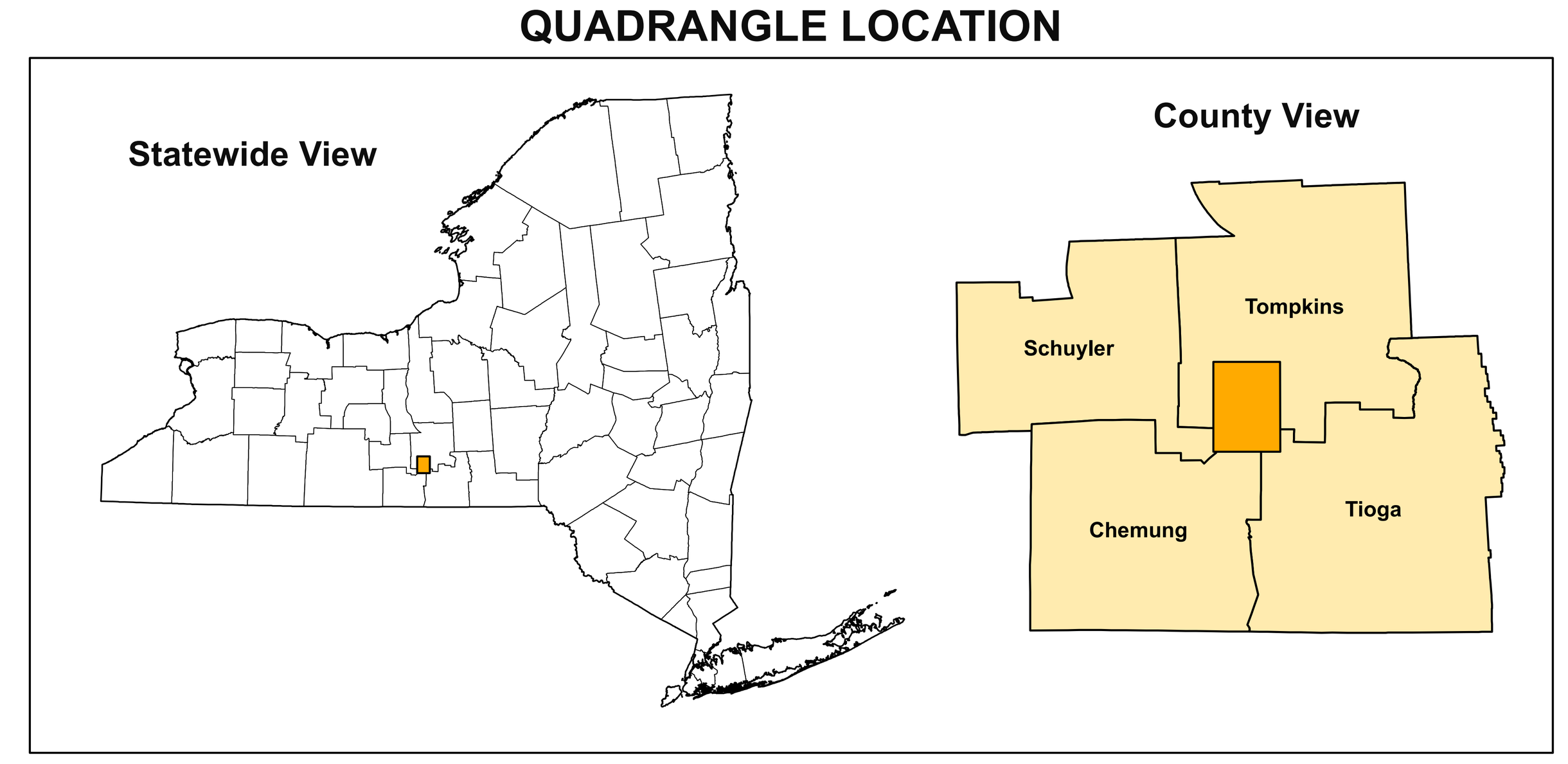
CROSS-SECTION A-A'



SYMBOLS

Streets	County Lines	Cross-Section Lines	NYSDEC Oil & Gas Well Location
Highways	Water Bodies	NYSGS Soil Sample Location	Eskers
Railroads	Streams	NYSDOT Boring Location	Moraines
Airport Runway	Contours	NYSDEC Water Well Location	

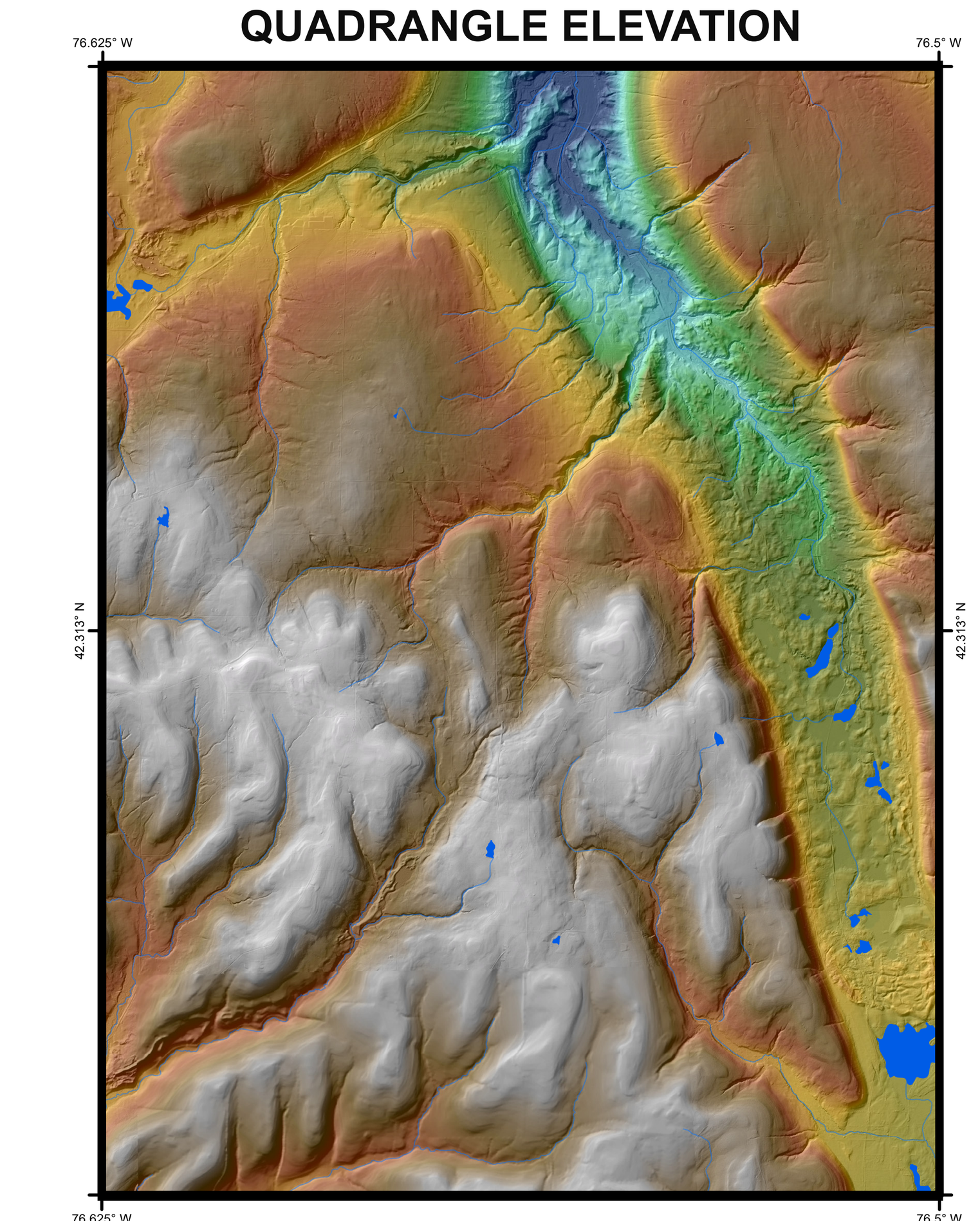
QUADRANGLE LOCATION



ADJOINING QUADRANGLES

Mecklenburg	Ithaca West	Ithaca East
Alpine	West Danby	Willseyville
Erin	Van Etten	Spencer

QUADRANGLE ELEVATION



1:75,000 scale; 2x vertical exaggeration

Shaded relief generated from 2012 Seneca Lake Watershed 2-meter, 2008 Tompkins County Soil and Water Conservation 2-meter and the 2000 NYS 10-meter lidar data sets.

New York State Museum Map & Chart No. 130

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