How did this land form?

A glacier is " *a mass of ice that moves over land under it's own weight through the action of gravity* (Montgomery 1997)." Several conditions must exist for a glacier to form: sufficient moisture, the climate must be cold enough for snow to fall, summer melting must be less than winter snowfall, and the accumulated snowfall must be transformed into ice that begins to flow outward. Today we find these conditions mostly at the top of mountains or at high latitudes. **Glaciers** that cover large areas of a continent and are more than one-half mile thick are called continental glaciers. Continental glaciers (also called ice sheets or ice caps) covered the area between Glens Falls and Albany during several different glacial periods. The most recent glaciation that is responsible for the current surficial geology of the area is termed the Pleistocene (Figure 1) and occurred

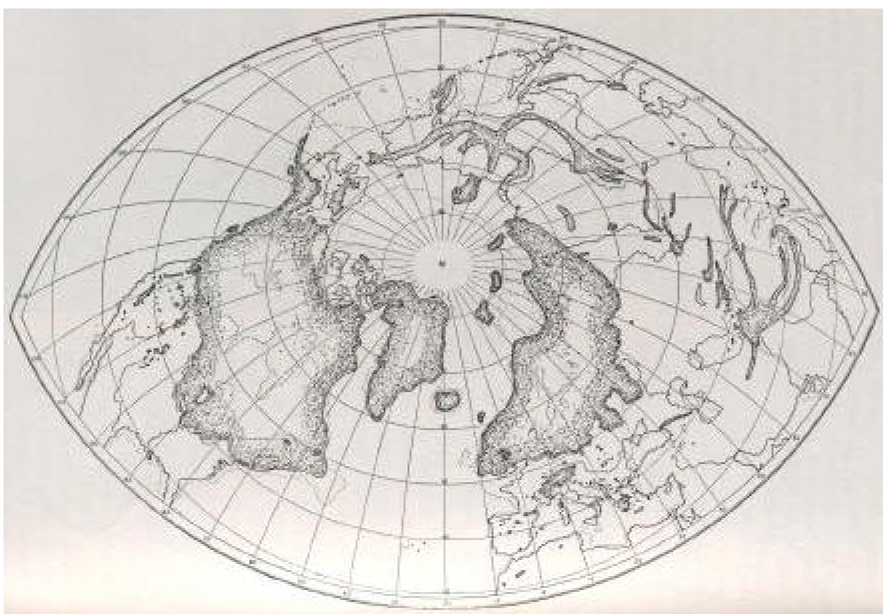

Fig. 1 – **Pleistocene** glaciation in the Northern Hemisphere (Woodford 1965)

from approximately 60,000 to 70,000 years ago to about 11,000 years ago.

The name of the glacier that covered the northern United States during this period is the Wisconsonian. As the Hudson Valley Lobe (near Lake Iroquois) (Fig. 2) of the Wisconsonian Ice Sheet retreated, the sediments deposited beneath it formed till. **Till** is a general term for unstratified deposit accumulating when the sediments in the glacier are dropped in place as the glacier melts. Ice-contact sands and gravels formed at the very edge of the glacier, and were also deposited by streams flowing off of the glacier. Glacial

Lake Albany (Figure 2), which existed from 15,000 to 12,600 years B.P. (before present), expanded to its maximum length of about 160 miles and extended from Newburgh to Glens Falls, NY (Dineen 1982).

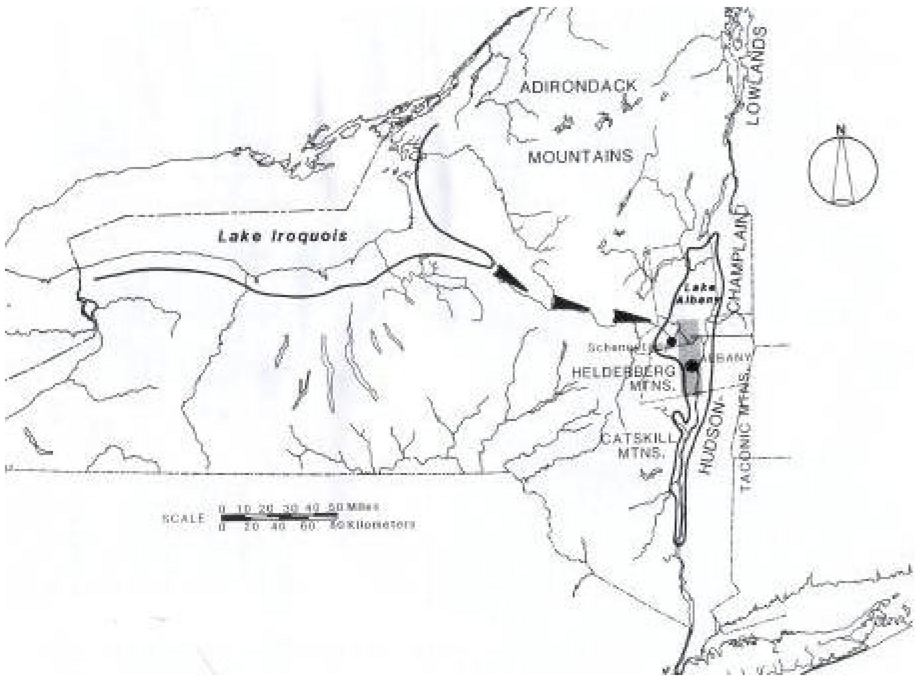

Fig. 2 - The formation of Glacial Lake Albany in response to the melting and retreat of the Wisconsonian Ice Sheet (Dineen & Hanson 1983)

As the meltwater flowed into Glacial Lake Albany, various size particles, ranging from gravel to sand to silt to clay, were deposited in the subaqueous (under water) environment. Where the velocity of the glacial meltwater entering the lake was high, the coarsest sediments were deposited on the lake bottom (as shown by the more rapid settling velocity of course soils in exercise 3 of the Soil Texture module). As the velocity decreased toward the center of the lake, finer sediments (silts and clays) were then deposited. As the size of the lake increased with the receding glacial front, the shallow lake became deeper and encompassed more area. Consequently, lake bottom deposits that were primarily coarse, were covered with finer silts and clays as the meltwater velocities in these locations decreased. Various interlayers of finer and coarser sediments were formed resulting from variations in the depositional environment between seasons and rainfalls. Today **Geomorphologists** can look at a gravel or sand pit and infer the energy and depth of the old water body in which the deposit formed simply by looking at the size of the soil particles.

The glacier continued to retreat (Figure 3) and became smaller, as the earth gradually began a warming cycle. Sands were deposited on top of the lake's silt and clay by superficial streams in a river delta environment. When these delta sands were exposed

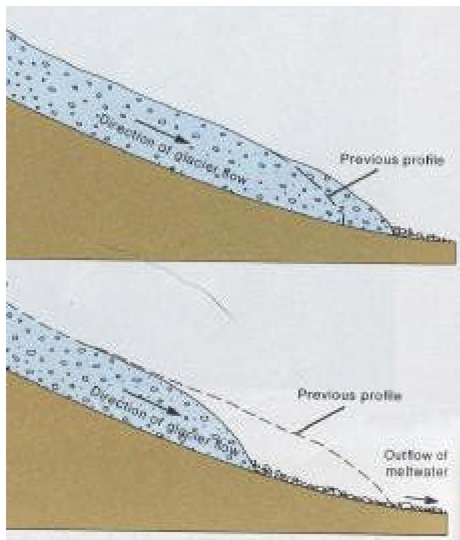

Fig. 3 - The advance and retreat of a glacier (Montgomery 1997).

to an **aeolian** (air) environment, as opposed to the previous aqueous environment, they began to dry up. Wind modified the sands from parallel, layered sand deposits to non-parallel sand dunes. Over the past thousands of years, the sand dunes were subject to constant modification by wind, rain, and vegetation.

The deposition of sediment as a result of the above outlined sequence of the retreat of the Wisconsonian Ice Sheet is evident in the subsurface of the Albany region today. A typical profile of the subsurface (described from the bedrock to the present day soil layers) consists of:

Paleozoic Ordovician shale and **graywacke** eroded by pre-Pleistocene streams.

Pleistocene Woodfordian successively overlies the bedrock.

Till (map symbol: QT, 1.5-15.0m thick)

Ice-contact sand and gravel (map symbol: QI, 0.3-3.0m thick)

Lake Albany silt and clay (map symbol: QLAC, 8.0-50.0m thick)

Lake Albany silt and sand (map symbol: QLAM, 0.3-15.0m thick)

Lake Albany sand (map symbol: QLAS, 0.3-15.0m thick)

Clay layer (map symbol: QLAV, 0.5-3.0m thick)

Quaternary Holocene dune sand (map symbol: QDS, 1.5-30.0m)

Recent artificial fill (map symbol: AF, 0.3-15.0m).

Note: For a more in-depth depiction of the subsurface geology consult Dineen (1982).

Not all areas will have a complete succession of these formations, but they will be very similar in context.

Exercise – What is the geology in your backyard?

Objectives:

To learn how to identify the surficial geology of a glacial region via the surficial geology map of eastern New York and to understand how that area was formed.

Materials:

Locate a New York State surficial geology map of the Hudson-Mohawk Region by:

1) Viewing the copied map below
2) Logging onto the website http://www.nysm.nysed.gov/gis.html#state and locating the Hudson-Mohawk sheet under the surficial geology section.
    a) If you have Arc View or another GIS application, you can use the Import71 utility to extract the .e00 file hudm_s.zip
    b) If you don't operate a GIS application, click on Interactive Hudson Mohawk
3) Ordering the map from: The New York State Museum Gift Shop at (518) 449-7860, ask for:
    Map #40 - Surficial Geologic Map of New York consisting of five sheets: Finger Lakes, Hudson-Mohawk, Niagara, Lower Hudson and Adirondack
    D. H. Caldwell and others
    $12.00/sheet
    $60.00/set
4) Visiting your library

Methods:

1) Utilizing the surficial geology map and provided key (Figure 4), locate the area that

you will be visiting.

2) Identify the geology and soil of the area.

3) Ask questions. How might this area have formed? Under a lake? At the tip of a glacier? What is the time frame and environmental events that helped form this geology?

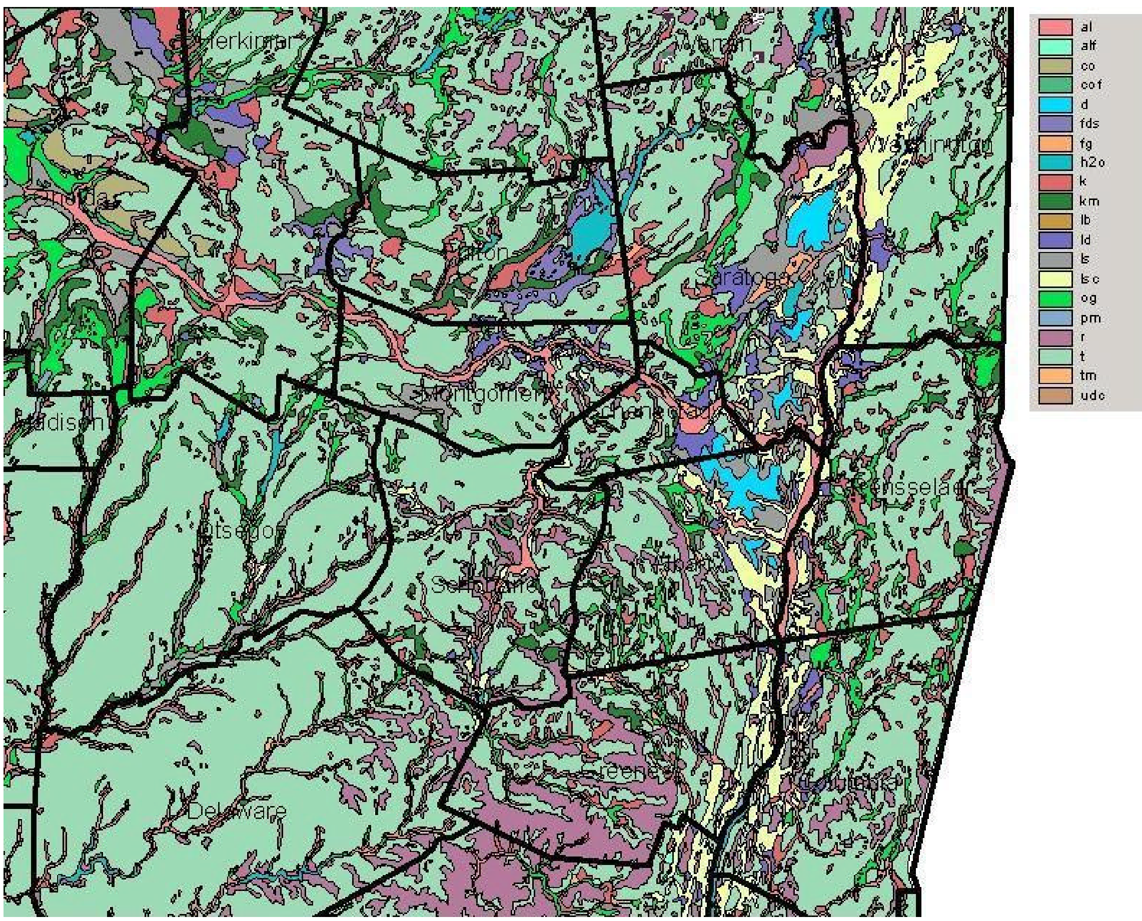

Fig. 4 – Surficial Geology of the Hudson Mohawk Sheet (http://www.nysm.nysed.gov/gis.html#state)

NYS Surficial Geology Material Legend

af - Artificial fill

al - Recent alluvium - Oxidized fine sand to gravel, permeable, generally confined to flood plains within a valley, in larger valleys may be overlain by silt, subject to flooding, thickness 1-10 meters.

alf - Alluvial fan - Poorly stratified silt, sand, and boulders, fan shaped accumulations, at bottoms of steep slopes, generally permeable, thickness 1-10 meters.

ali - Alluvial inwash - Deposited between active or remnant glacier ice and draped on adjacent valley wall, lacks kettles, permeability varies, thickness variable (2-10 meters).

alt - Alluvial terrace - Fluvial sand and gravel, occasional laterally continuous lenses of silt, remnants of earlier higher flood plains, generally permeable, thickness 1-10 meters.

alp - Pleistocene alluvium - well rounded and stratified, generally finer texture away from ice border, permeable, thickness variable (2-20 meters).

b – Beach - Sand and gravel deposit at marine shorelines, thickness variable.

cd - Colluvial diamicton - Mixture of sediments, unique to region beyond Wisconsinan glacial limit, rebedded saprolite and glacial debris, may be old (Illinoian) drift, homogenized by varying degrees of colluviation, bedrock may sporadically crop out or be within 1 - 3 meters of the surface.

co, col – Colluvium -Mixture of sediments, deposited by mass wasting, thickness generally 1 - 5 meters.

cof - Colluvial fan - Fan shaped accumulation, mixture of sediments, at mouths of gullies, thickness generally 1 - 5 meters.

d – Dunes - Fine to medium sands, well sorted, stratified, generally wind-reworked lake sediment, permeable, well drained, thickness variable 1-10 meters.

fds - Fluvial deltaic sand - Same as outwash sand and gravel, except deposition further from glaciers, age uncertain.

fg - Fluvial sand and/or gravel - Sand and/or gravel, occasional laterally continuous lenses of silt, deposition farther from glacier than outwash, age and proximity to ice uncertain, permeable, thickness variable (1-20 meters).

k - Kame deposits - Coarse to fine gravel and/or sand, includes kames, eskers, kame terraces, kame deltas, ice contact, or ice cored deposition, lateral variability in sorting, texture and permeability, may be firmly cemented with calcareous cement, thickness variable (10-30 meters).

ki – Inwash - Coarse to fine gravel and/or sand, interpreted as alluvium deposited adjacent to active or remnant ice by streams of nonglacial origin, thickness variable (2-20 meters).

km - Kame moraine - Variable texture (size and sorting) from boulders to sand, deposition at an active ice margin during retreat, constructional kame and kettle topography, locally, calcareous cement, thickness variable (10-30 meters).

lb - Lacustrine beach - Generally well sorted sand and gravel, stratified, permeable and well drained, deposited at lake shoreline, generally non-calcareous, may have wave-winnowed lag gravel, thickness variable (1-5 meters).

ld - Lacustrine delta - Coarse to fine gravel and sand, stratified, generally well sorted, deposited at a lake shoreline, thickness variable (3-15 meters).

ls - Lacustrine sand - Generally quartz sand, well sorted, stratified, usually deposited in proglacial lakes, but may have been deposited on remnant ice, generally a near-shore deposit or near a sand source, permeable, thickness variable (2-20 meters).

lsc - Lacustrine silt and clay - Generally laminated silt and clay, deposited in proglacial lakes, generally calcareous, low permeability, potential land instability, thickness variable (up to 50 meters).

mb - Marine beach - Generally well sorted sand and gravel, elevation at or below highest marine level, permeable and well drained, may be fossiliferous, deposited in brackish to salt water, thickness variable (1-5 meters).

md - Marine delta - Coarse to fine gravel and sand, elevation at or below highest marine level, stratified, generally well sorted, deposited in brackish to salt water, permeable, thickness variable (3-15 meters).

og - Outwash sand and gravel - Coarse to fine gravel with sand, proglacial fluvial deposition

pm - Swamp deposits - Peat-muck, organic silt and sand in poorly drained areas, unoxidized, commonly overlies marl and lake silt, potential land instability, thickness 2-20 meters.

r – Bedrock - Exposed or generally within 1 meter of surface, in some areas saprolite is preserved.

s - Undifferentiated marine and lacustrine sand - Well sorted, stratified, fine to medium sand, generally a near-shore deposit, at or below highest marine level, may include fossil shells, may be a brackish to salt water deposit, permeable, thickness variable (2-20 meters).

sc - Undifferentiated marine and lacustrine silt and clay - Elevation within highest marine level, generally laminated to massive silt and clay, may include fossil shells, deposited in brackish to salt water, low permeability, potential land instability, thickness variable (up to 50 meters).

sf - Subaqueous fan - Coarse to fine gravel and/or sand, variable texture and sorting, deposited adjacent to glacier with englacial or subglacial conduit debouching in deep water, thickness variable (5-30 meters).

t – Till - Variable texture (boulders to silt), usually poorly sorted sand-rich diamict, deposition beneath glacier ice, permeability varies with compaction, thickness variable (1-50 meters)

ta - Ablation moraine - Till, deposited by downwasting, with minor amounts of sand and silt, deposition during final melting of glacier, thickness variable (1-10 meters).

tm - Till moraine - Variable texture (size and sorting), generally low permeability, deposition adjacent to ice, thickness variable (10-30 meters).

usda - Undifferentiated stratified drift assemblage - Dominantly clay, silt and sand, limited gravel and diamicton, stratification includes undisturbed and deformed laminations, ice-contact structures, lenticular, discontinuous bodies of gravel and flow till, may represent dead-ice, disintegration and local ice-contact lake deposits in ice-marginal and subglacial environments, thickness variable (10 - 30 meters).

Geology websites:

http://www.homepage.montana.edu/~geol445/hyperglac/glossary.htm
http://ggg.qub.ac.uk/papers/frame.htm
http://www.science.ubc.ca/~geol100/fletcher/slideshow/glacial/glacial.html
http://www.expage.com/page/glacialgeology
http://www.uoguelph.ca/~sadura/glref/glres.htm
http://www.colorado.edu/INSTAAR/TEAML/atlas/chapters/regdesc/glacgeo.html#seq
http://www.nysm.nysed.gov/gis.html#state

Key words: surficial geology, Pleistocene, glacial geology, and glacier

Sources:

Dineen, R.J. 1982. The Geology of the Pine Bush Aquifer, North-Central Albany County, NY. Bulletin # 449 New York State Museum. The University of the State of New York, New York

Dineen, R.J., E.L. Hanson. 1983. Bedrock Topography and Glacial Deposits of the Colonie Channel between Saratoga Lake and Coeymans, NY. Map and chart series #37 New York State Museum. The University of the State of New York, New York

Montgomery, C.W. 1997. Environmental Geology, 5th ed. WCB/McGraw-Hill Companies, Inc. New York, 193-199.

Woodford, A.O. 1965. Historical Geology. W.H. Freeman and Com. San Fransico, CA 440-441.

http://www.nysm.nysed.gov/gis.html#state

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