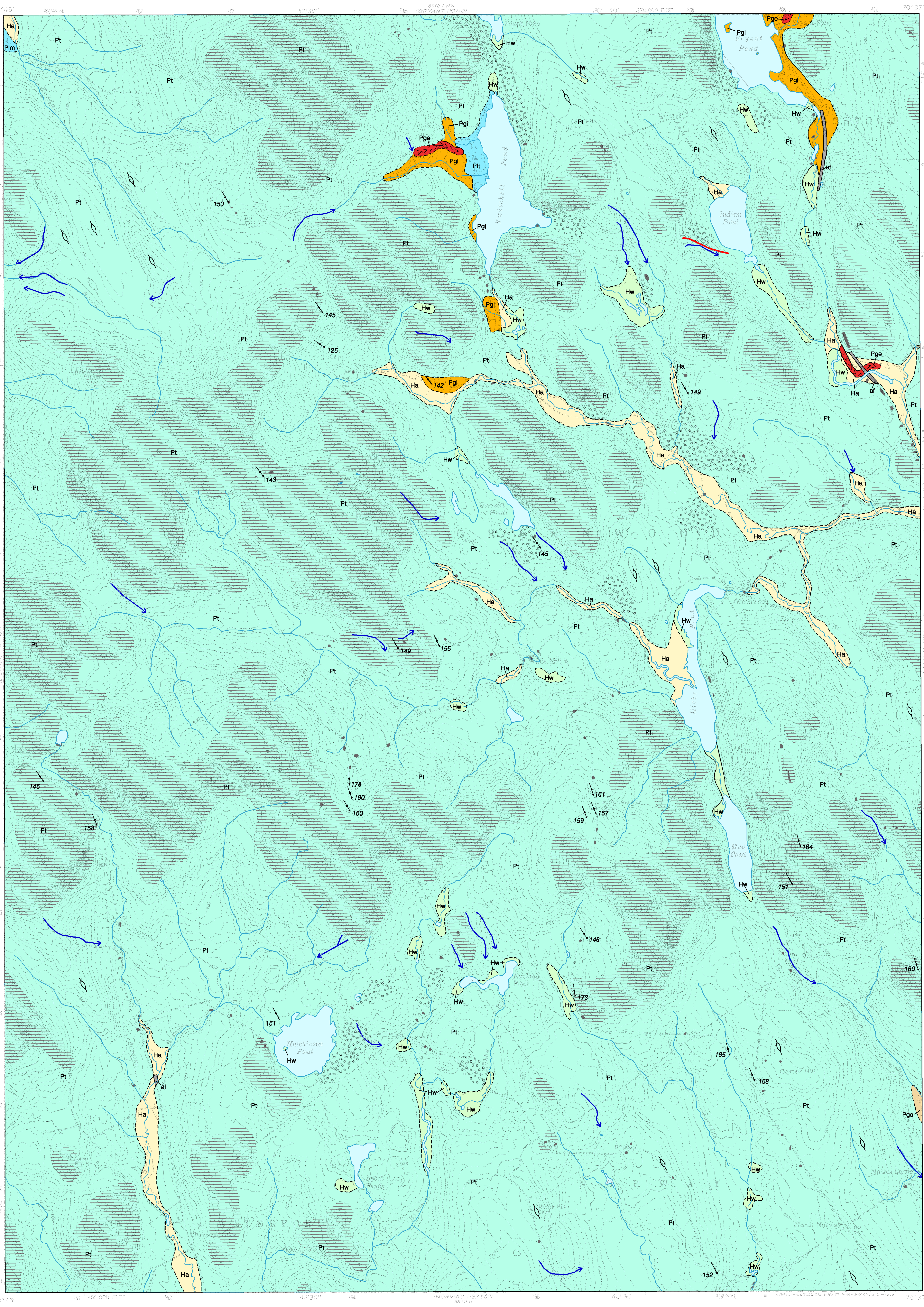
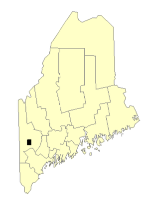
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping of the Greenwood quadrangle was conducted by Woodrow B. Thompson in 1982-83 for the Maine Geological Survey's sand and gravel aquifer mapping program and in 2006-7 for the STATEMAP program. Additional data were collected during the 1980's and 1990's by W. B. Thompson, including information from pipeline construction in 1998.



Quadrangle Location

SCALE 1 : 24,000

1 MILE · 1000 0 1000 2000 3000 4000 5000 6000 7000 FEET · 1 KILOMETER

CONTOUR INTERVAL 20 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Greenwood quadrangle, scale 1:24,000 using standard U.S. Geological Survey topographic map symbols.

The use of industry, firm, or local government names on this map is for location purposes only and does not impute responsibility for any present or potential effects on the natural resources.

Symbol	Explanation
Ha	**Stream alluvium** - Sand, silt, gravel, and organic sediment. Deposited on flood plains of streams. Unit includes some wetland areas, and may also include low terraces that are not flooded often.
Hw	**Wetland deposits** - Peat, muck, silt, and clay. Deposited in poorly drained areas on valley floors. Unit may grade into or include areas of stream alluvium.
Plt	**Glacial Lake Twitchell deposits** - Sand and gravel deposited in a glacial lake that occupied the Twitchell Pond basin and had a slightly higher water level than the modern pond.
Plm	**Glacial Lake Mill Brook deposits** - Sand and gravel deposited by glacial meltwater flowing into the Mill Brook valley in the adjacent East Stoneham quadrangle.
Pgo	**Outwash** - Sand and gravel deposited by a glacial meltwater stream near the southeast corner of the quadrangle.
Pgi	**Ice-contact deposits** - Sand and gravel deposits formed in contact with remnants of glacial ice.
Pge	**Esker deposits** - Sand and gravel deposited by meltwater streams in subglacial tunnels that developed in valleys.
Pt	**Till** - Loose to very compact, poorly sorted, massive to weakly stratified mixture of sand, silt, and gravel-size rock debris deposited by glacial ice. Locally includes lenses of water-laid sand and gravel.
	Bedrock outcrops/thin-drift areas - Ruled pattern indicates areas where outcrops are common and/or surficial sediments are generally less than 10 ft thick (mapped partly from air photos). Dots show individual outcrops.
af	**Artificial fill** - Earth, rock, and/or man-made fill along roads and railroads.

Contact - Boundary between map units. Dashed where approximately located.

Glacially streamlined hill - Symbol shows trend of long axis, which is parallel to former glacial ice-flow direction.

135 **Glacial striation locality** - Arrow shows ice-flow direction inferred from striations on bedrock. Dot marks point of observation. Number is azimuth (in degrees) of flow direction.

End moraine - Red line indicates the axis of a till ridge which is inferred to have been deposited at the margin of the last ice sheet in late-glacial time. The moraine is located southwest of Indian Pond.

Meltwater channel - Channel eroded by a glacial meltwater stream. Arrow shows inferred direction of water flow.

>>>>> **Crest of esker** - Shows trend of esker ridge. Chevrons point in direction of glacial meltwater flow.

Area of large boulders - Area of glacial till where there are many large boulders, typically 3-5 ft or larger, scattered over the ground surface. These areas have been mapped only where observed, and they are likely to occur elsewhere in the till-covered uplands.

USES OF SURFICIAL GEOLOGY MAPS

A surficial geology map shows all the loose materials such as till (commonly called hardpan), sand and gravel, or clay, which overlie solid ledge (bedrock). Bedrock outcrops and areas of abundant bedrock outcrops are shown on the map, but varieties of the bedrock are not distinguished (refer to bedrock geology map). Most of the surficial materials are deposits formed by glacial and postglacial processes during the last stage of continental glaciation, which began about 25,000 years ago. The remainder of the surficial deposits are the products of postglacial geologic processes, such as river floodplains, or are attributed to human activity, such as fill or other land-modifying features.

The map shows the areal distribution of the different types of glacial features, deposits, and landforms as described in the map explanation. Features such as striations and moraines can be used to reconstruct the movement and position of the glacier and its margin, especially as the ice sheet melted. Other ancient features include shorelines and deposits of glacial lakes or the glacial sea, now long gone from the state. This glacial geologic history of the quadrangle is useful to the larger understanding of past earth climate, and how our region of the world underwent recent geologically significant climatic and environmental changes. We may then be able to use this knowledge in anticipation of future similar changes for long-term planning efforts, such as coastal development or waste disposal.

Surficial geology maps are often best used in conjunction with related maps such as surficial materials maps or significant sand and gravel aquifer maps for anyone wanting to know what lies beneath the land surface. For example, these maps may aid in the search for water supplies, or economically important deposits such as sand and gravel for aggregate or clay for bricks or pottery. Environmental issues such as the location of a suitable landfill site or the possible spread of contaminants are directly related to surficial geology. Construction projects such as locating new roads, excavating foundations, or siting new homes may be better planned with a good knowledge of the surficial geology of the site. Refer to the list of related publications below.

OTHER SOURCES OF INFORMATION

1. Thompson, W. B., and Locke, D. B., 2007, Surficial materials of the Greenwood quadrangle, Maine: Maine Geological Survey, Open-File Map 07-68.
2. Neil, C. D., 2007, Significant sand and gravel aquifers of the Greenwood quadrangle, Maine: Maine Geological Survey, Open-File Map 07-75.
3. Thompson, W. B., 1979, Surficial geology handbook for coastal Maine: Maine Geological Survey, 68 p. (out of print).
4. Thompson, W. B., and Borns, H. W., Jr., 1985, Surficial geologic map of Maine: Maine Geological Survey, scale 1:500,000.

Greenwood Quadrangle, Maine

Surficial geologic mapping by
Woodrow B. Thompson

Digital cartography by:
Susan S. Tolman

Robert G. Marvinney
State Geologist

Cartographic design and editing by:
Robert D. Tucker

Funding for the preparation of this map was provided in part by the U.S. Geological Survey STATEMAP Program, Cooperative Agreement No. 06HQAG0026.

DEPARTMENT OF CONSERVATION MAINE

Maine Geological Survey

Address: 22 State House Station, Augusta, Maine 04333
Telephone: 207-287-2801 **E-mail:** mgs@maine.gov
Home page: http://www.maine.gov/doc/nrimc/nrimc.htm

Open-File No. 07-67
2007

SURFICIAL GEOLOGY OF MAINE

Continental glaciers like the ice sheet now covering Antarctica probably extended across Maine several times during the Pleistocene Epoch, between about 1.5 million and 10,000 years ago. The slow-moving ice superficially changed the landscape as it scraped over mountains and valleys, eroding and transporting boulders and other rock debris for miles. The sediments that cover much of Maine are largely the product of glaciation. Glacial ice deposited some of these materials, while others washed into the sea or accumulated in meltwater streams and lakes as the ice receded. Earlier stream patterns were disrupted, creating hundreds of ponds and lakes across the state. The map at left shows the pattern of glacial sediments in the Greenwood quadrangle.

The most recent "Ice Age" in Maine began about 25,000 years ago, when an ice sheet spread southward over New England (Stone and Borns, 1986). During its peak, the ice was several thousand feet thick and covered the highest mountains in the state. The weight of this huge glacier actually caused the land surface to sink hundreds of feet. Rock debris frozen into the base of the glacier abraded the bedrock surface over which the ice flowed. The grooves and fine scratches (striations) resulting from this scraping process are often seen on freshly exposed bedrock, and they are important indicators of the direction of ice movement. Erosion and sediment deposition by the ice sheet combined to give a streamlined shape to many hills, with their long dimension parallel to the direction of ice flow. Some of these hills (drumlins) are composed of dense glacial sediment (till) plastered under great pressure beneath the ice.

A warming climate forced the ice sheet to start receding as early as 21,000 years ago, soon after it reached its southernmost position on Long Island (Sirkin, 1986). The edge of the glacier withdrew from the continental shelf east of Long Island and reached the present position of the Maine coast by 13,800 years ago (Dorion, 1993). Even though the weight of the ice was removed from the land surface, the Earth's crust did not immediately spring back to its normal level. As a result, the sea flooded much of southern Maine as the glacier retreated to the northwest. Ocean waters extended far up the Kennebec and Penobscot valleys, reaching present elevations of up to 420 feet in the central part of the state.

Great quantities of sediment washed out of the melting ice and into the sea, which was in contact with the receding glacier margin. Sand and gravel accumulated as deltas and submarine fans where streams discharged along the ice front, while the finer silt and clay dispersed across the ocean floor. The shells of clams, mussels, and other invertebrates are found in the glacial-marine clay that blankets lowland areas of southern Maine. Age dates on these fossils tell us that ocean waters covered parts of Maine until about 11,000 years ago, when the land surface rebounded as the weight of the ice sheet was removed.

Meltwater streams deposited sand and gravel in tunnels within the ice. These deposits remained as ridges (eskers) when the surrounding ice disappeared. Maine's esker systems can be traced for up to 100 miles, and are among the longest in the country.

Other sand and gravel deposits formed as mounds (kames) and terraces adjacent to melting ice, or as outwash in valleys in front of the glacier. Many of these water-laid deposits are well layered, in contrast to the chaotic mixture of boulders and sediment of all sizes (till) that was released from dirty ice without subsequent reworking. Ridges consisting of till or washed sediments (moraines) were constructed along the ice margin in places where the glacier was still actively flowing and conveying rock debris to its terminus. Moraine ridges are abundant in the zone of former marine submergence, where they are useful indicators of the pattern of ice retreat.

The last remnants of glacial ice probably were gone from Maine by 10,000 years ago. Large sand dunes accumulated in late-glacial time as winds picked up outwash sand and blew it onto the east sides of river valleys, such as the Androscoggin and Saco valleys. The modern stream network became established soon after deglaciation, and organic deposits began to form in peat bogs, marshes, and swamps. Tundra vegetation bordering the ice sheet was replaced by changing forest communities as the climate warmed (Davis and Jacobson, 1985). Geologic processes are by no means dormant today, however, since rivers and wave action modify the land, and worldwide sea level is gradually rising against Maine's coast.

References Cited

Davis, R. B., and Jacobson, G. L., Jr., 1985, Late-glacial and early Holocene landscapes in northern New England and adjacent areas of Canada: Quaternary Research, v. 23, p. 341-368.

Dorion, C. C., 1993, A chronology of deglaciation and accompanying marine transgression in Maine: Geological Society of America, Abstracts with Programs, v. 25, no. 2, p. 12.

Sirkin, L., 1986, Pleistocene stratigraphy of Long Island, New York, *in* Caldwell, D. W. (editor), The Wisconsinan stage of the first geological district, eastern New York: New York State Museum, Bull. 455, p. 6-21.

Stone, B. D., and Borns, H. W., Jr., 1986, Pleistocene glacial and interglacial stratigraphy of New England, Long Island, and adjacent Georges Bank and Gulf of Maine, *in* Sibrava, V., Bowen, D. Q., and Richmond, G. M. (editors), Quaternary glaciations in the northern hemisphere: Quaternary Science Reviews, v. 5, p. 39-52.

Figure 1: View looking southeast from Uncle Tom Mountain, showing Noyes Mountain in the distance. The large field (near left edge of photo) is on a smoothly sloping till deposit plastered against the north end of Noyes Mountain by overriding glacial ice.

Figure 2: Payne Ledge on east side of Twitchell Pond in Greenwood. This high cliff resulted from glacial plucking of bedrock on the south face of Rowe Hill.

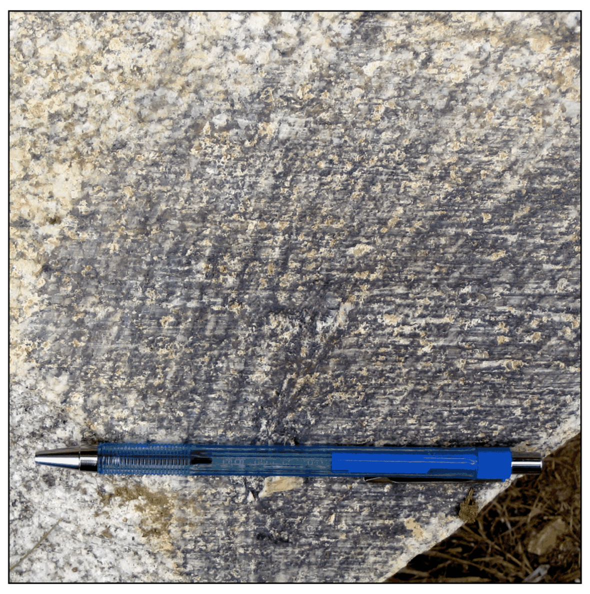


Figure 3: Glacial striations revealed by pencil rubbing on smooth surface of granite ledge, northeast side of The Nubble in Greenwood. The ice flow direction was 160° (from right to left, parallel to the pen).

Figure 4: Till exposed in pit near west end of Route 219 in Greenwood City. This material is typical of the sandy, granite-rich, light-gray till deposited by the most recent glacial ice sheet in the Oxford Hills region. Boulders are concentrated in the upper part of the exposure, and the till contains many deformed lenses of sand and silt.

Figure 5: Glacial pothole in ledge on west side of Twitchell Pond Road in Greenwood. This feature was scoured into bedrock by a whirlpool of meltwater flowing between the ice and the valley wall. It is only a partial pothole because it is not surrounded by bedrock on all sides. The meltwater stream that carved it is presumed to have been confined by ice on the side toward the valley.

Figure 6: Pit exposure showing cross section of esker ridge west of Twitchell Pond. The esker was deposited by an ice-walled meltwater stream. The glacial drainage in this area eroded a meltwater channel on the hillside at the west end of the esker, and also cut the large channel farther west between Tibbetts Mountain and Elwell Mountain.

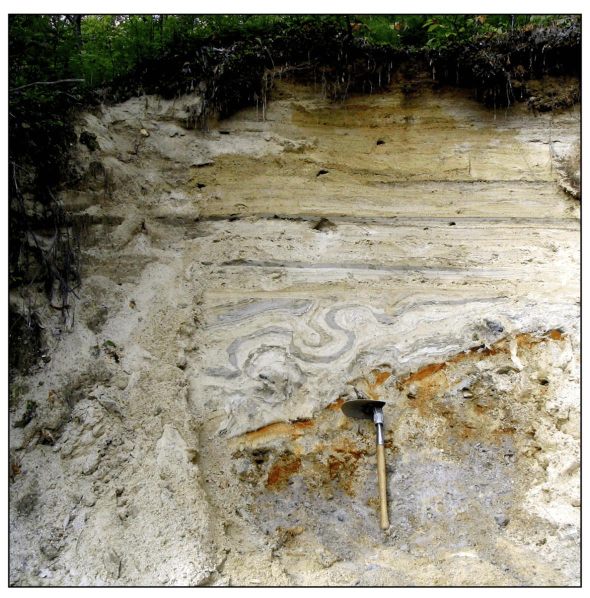


Figure 7: Pit face in the Sanborn River valley, west of Willis Mill in Greenwood. This exposure shows glacial outwash (interbedded sand, gravelly sand, and gray silt) overlying till. The contact with the till is marked by the orange oxidation layer just above the shovel blade. The lower sand-silt beds were contorted by slumping (possibly resulting from melting of adjacent ice), and these deformed sediments were then eroded and covered by the undisturbed horizontal beds in the upper half of the section.

Figure 8: Sanborn River at road crossing east of Willis Mill. This scenic waterfall is typical of many places in the Oxford Hills where upland streams have eroded through glacial sediments and flow over bedrock.