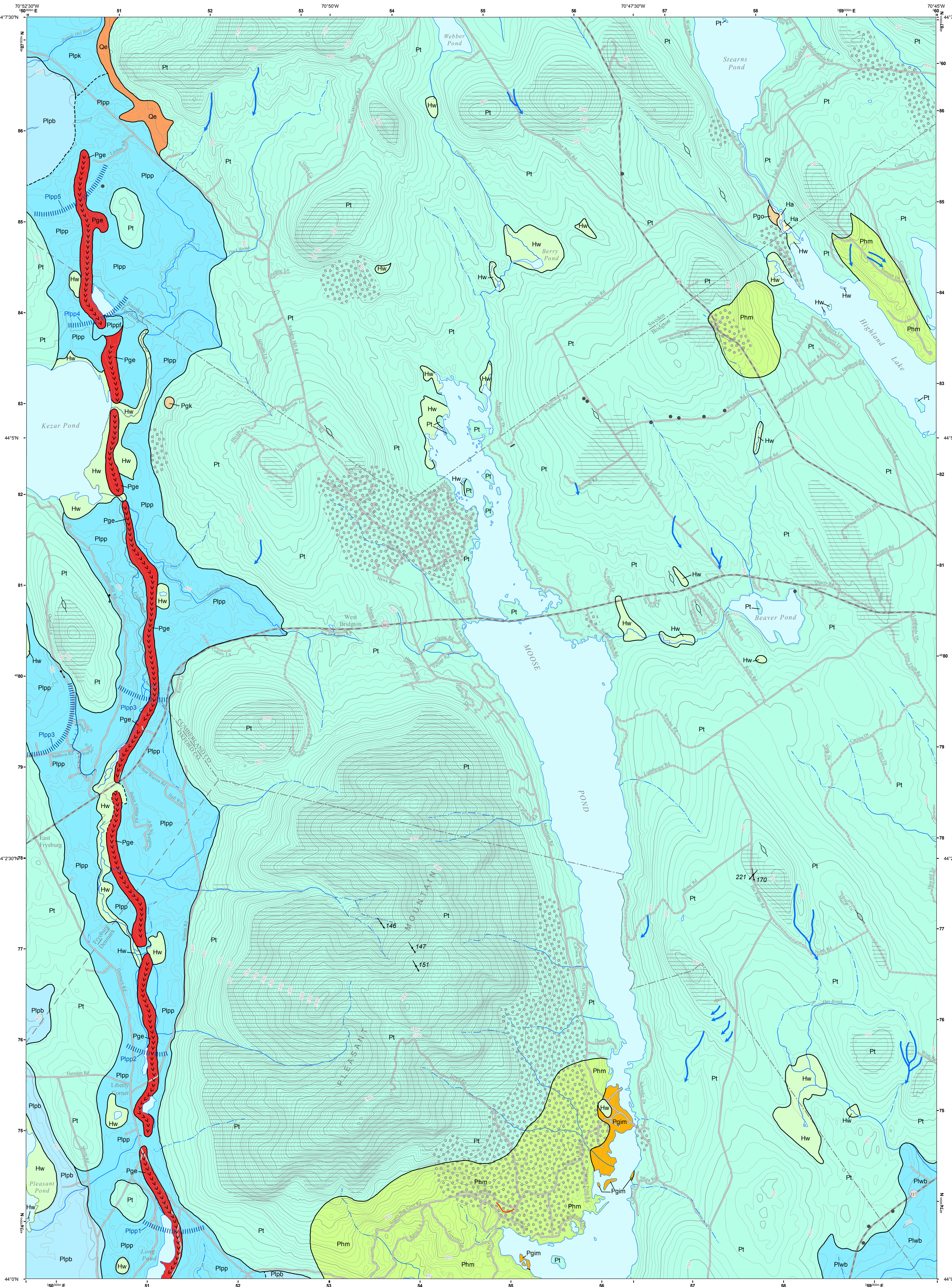
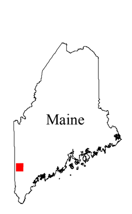
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping of the Pleasant Mtn. quadrangle was conducted by W. B. Thompson in 1976 under funding from the Greater Portland Council of Governments (Cumberland Co. portion), and in 1988 under funding from the MGS. The author updated earlier observations in 1998-1999 to complete this map under funding from the MGS/USGS STATEMAP cooperative.



Center Lovell	North Waterford	Waterford Flat
Fryeburg	Pleasant Mtn	Bridgton
Brownfield	Hiram	North Sebago

SCALE 1:24,000

1 Mile · 7000 Feet · 1 Kilometer

CONTOUR INTERVAL 20 FEET

Base map features from Maine Office of GIS - 1:24,000 USGS contour lines, E911 roads, 1:24,000 National Hydrography Dataset, USGS GNIS placenames and 1:24,000 political boundaries.

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.

Note: The first letter of each map unit indicates the general age of the unit:
H = Holocene (postglacial deposit; formed during the last 11,700 years).
Q = Quaternary (deposit of uncertain age usually late-glacial and/or postglacial).
P = Pleistocene (deposit formed during glacial to late-glacial time, prior to 11,700 yr B.P. [years before present]).

Ha — **Alluvium** - Sand, gravel, silt, and organic sediment. Deposited on flood plains of modern streams.

Hw — **Wetland deposits** - Peat, muck, silt, and clay. Deposited in poorly drained areas.

Qe — **Eolian deposits** - Windblown sand. Forms dunes and irregular blanket deposits.

Plpk, Plpp, Plppf, Plpb — **Glacial Lake Pigwacket deposits** - Sand, gravel, and silt deposited in glacial Lake Pigwacket. Includes fan, delta, and lake-bottom sediments.

- Plpk - Kezar Valley stage deposits - Formed in an ice-dammed lake that extended up to the Kezar River valley (north of the quadrangle).
- Plpp - Pleasant Mountain stage deposits - Formed in an ice-dammed lake flanking the esker in western part of the quadrangle.
- Plppf - Fan deposited into Pleasant Mountain stage of Lake Pigwacket at mouth of ice tunnel.
- Plpb - Lake-bottom deposits.

Pgo — **Outwash deposits** - Outwash sand deposited by glacial meltwater stream in valley between Stearns Pond and Highland Lake.

Pgk — **Kame deposit** - Mound of ice-contact gravel deposited by glacial meltwater on hillside east of Kezar Pond.

Pgim — **Moose Pond deposits** - Ice-contact sand and gravel deposited by glacial outwash streams in the Moose Pond valley.

Plwb — **Willett Brook deposits** - Ice-contact sand and gravel; probably deposited into a glacial lake in the Willett Brook valley.

Pge — **Esker deposits** - Sand and gravel deposited by meltwater streams in a subglacial tunnel system. Unit may also include tunnel-mouth lacustrine fan deposits.

Phm — **Hummocky moraine** - Glacial till with hummocky topography. Consists of poorly sorted rock debris deposited by glacial ice. May contain variable proportions of sand and gravel. Locally very bouldery.

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). Gray dots show individual outcrops.

Contact - Boundary between map units. Dashed where very approximate.

Scarp - Scarp (delta front?) separating higher and lower depositional levels of glacial Lake Pigwacket sediments.

Ice-margin position - Line shows approximate position of the glacier margin during ice retreat, based on head of outwash for related meltwater deposits. Numbers indicate relative ages; "1" is oldest.

Moraine ridge - Symbol shows trend of moraine ridge in area of hummocky moraine south of Pleasant Mountain. Origin of ridge is unknown.

>>>>> **Esker ridge** - Shows trend of sand and gravel ridge deposited in a meltwater tunnel within or beneath glacial ice. Chevrons indicate direction of meltwater flow.

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(s) inferred from striations on bedrock. Dot marks point of observation. Number is azimuth (in degrees) of flow

Dip of cross-bedding - Dip of cross-bedding - Arrow shows average dip direction of cross-bedding in fluvial or deltaic deposits, which indicates direction of stream flow or delta progradation. Point of observation at dot.

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

Area of many large boulders.

Pleasant Mountain Quadrangle, Maine

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For additional information, see Open-File Report 99-6.

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 2.5 million and 11,700 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 this quadrangle.

The most recent "Ice Age" in Maine began about 30,000 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 calendar years ago, soon after it reached its southernmost position on Long Island (Ridge, 2004). The edge of the glacier withdrew from the continental shelf east of Long Island and reached the present position of the Maine coast by about 16,000 years ago (Borns and others, 2004). 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. Ages of these fossils tell us that ocean waters covered parts of Maine until about 13,000 years ago. The land rebounded as the weight of the ice sheet was removed, forcing the sea to retreat.

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 12,000 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.

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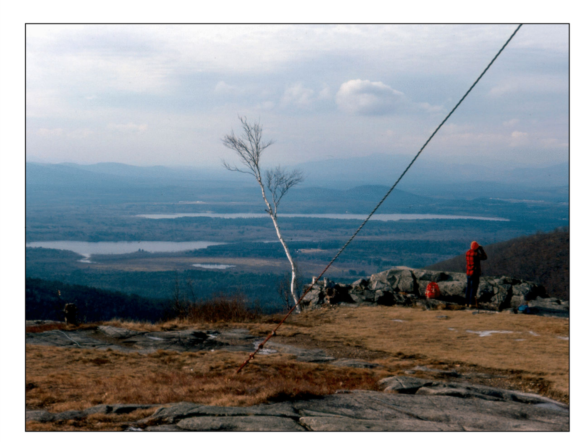

Figure 1. View looking southwest from the top of Pleasant Mountain. The more distant water body is Lovewell Pond in Fryeburg. Pleasant Pond and a large wetland are seen in center-left part of photo. The ledge in foreground is typical of the bedrock exposures found on the higher parts of most Maine mountains.

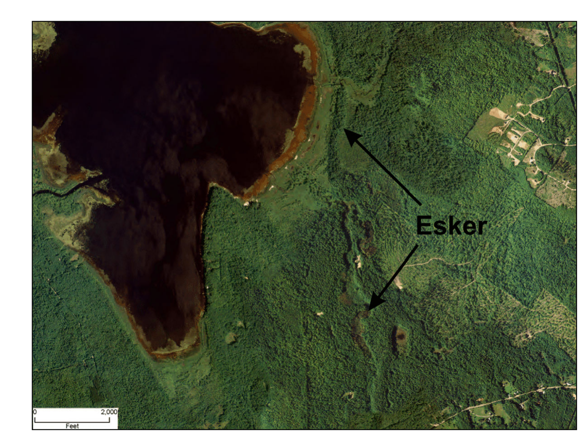

Figure 2: A major esker (map unit Pge) crosses the western part of the quadrangle from north to south, just east of Kezar Pond. The esker ridge is seen in the central part of this aerial photograph. It formed when a glacial meltwater stream deposited gravel and sand in a tunnel at the bottom of the last continental ice sheet.

Figure 3. Pit between Elkins Brook and Route 302 in East Fryeburg, in the western part of the quadrangle. The upper part of the pit face shows deltaic sand (map unit Plpp) deposited into the Pleasant Mountain stage of Lake Pigwacket. (See accompanying report by Thompson, 1999). The sediment in the delta was discharged from the receding mouth of the ice tunnel in which the local esker formed. The gravel in the lower part of the pit face is part of the esker.

Figure 4. Another exposure in same pit as Figure 3, showing deformed and steeply inclined foreset beds (center) of the Lake Pigwacket delta. These sand beds were deposited on the front of the delta as it built into the lake. They later slumped due to melting of adjacent glacial ice which had supported them.

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 deglacial 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.

OTHER SOURCES OF INFORMATION

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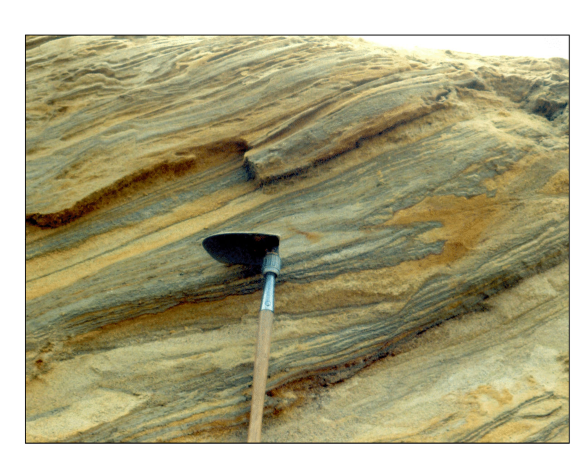

Figure 5. Close-up of silty to sandy foreset beds in Lake Pigwacket delta deposit (unit Plpp). This exposure was located in another pit in the Elkins Brook valley, just south of the locality in Figures 3 and 4.

Figure 6. Shaking Bog, just southwest of Liberty Corner in Denmark. This peat bog is one of numerous wetlands in the quadrangle (map unit Hw).