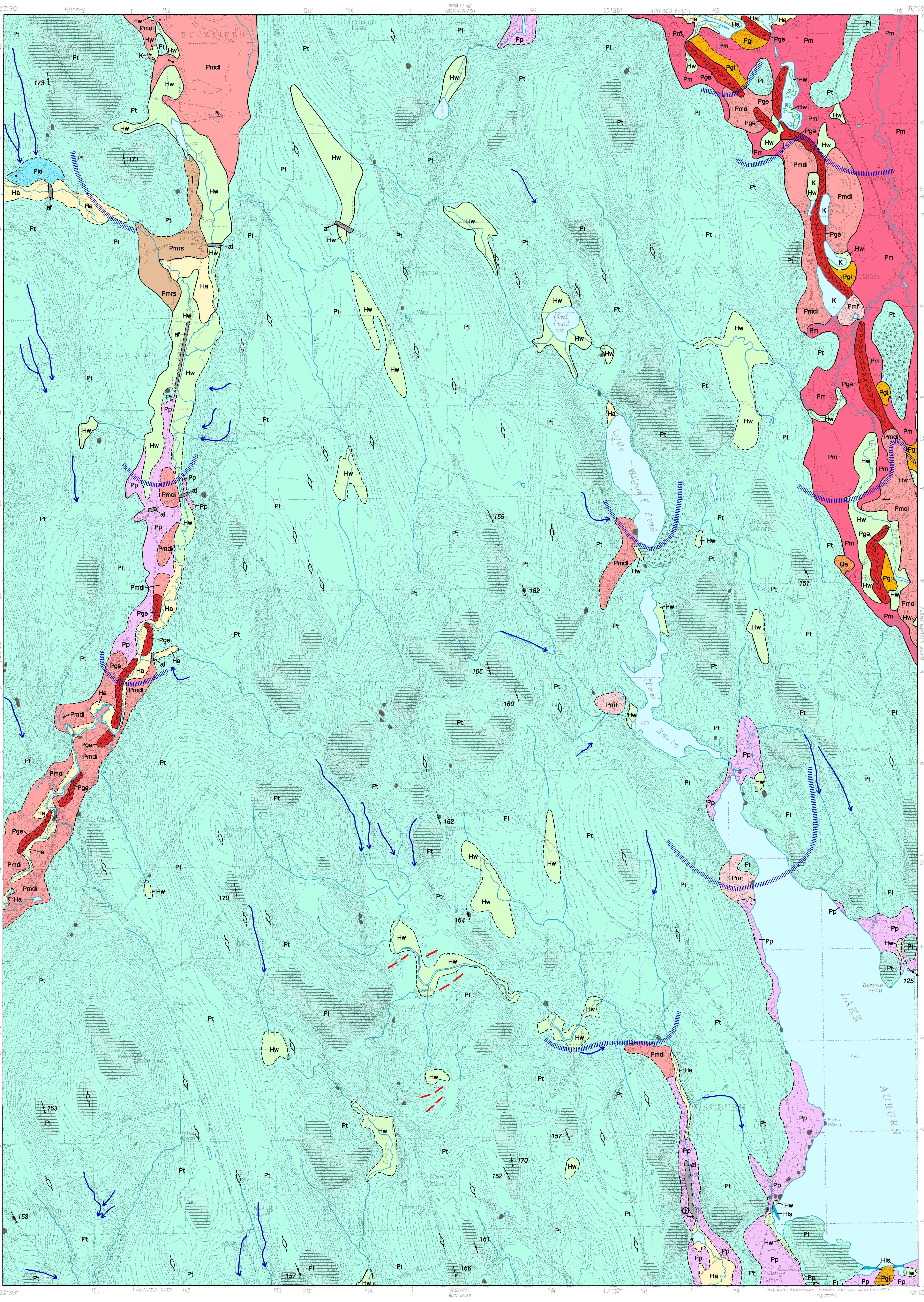
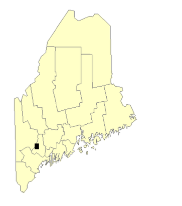
Surficial Geology



SOURCES OF INFORMATION

Modified in 2008 based on field work by Woodrow B. Thompson. Surficial geologic mapping by Woodrow B. Thompson completed during the 2000 field season; funding for this work provided by the U.S. Geological Survey STATEMAP program and the Maine Geological Survey, Department of Conservation.



Quadrangle Location

SCALE 1 : 24,000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Lake Auburn West 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.

- **Ha** — **Stream alluvium** - Sand, gravel, silt, and organic sediment. Deposited on flood plains of modern streams. Unit may include some wetland areas.
- **Hls** — **Modern beach deposit** - Sand and/or gravel with silt in places. Developed along the shorelines of lakes and ponds.
- **Hw** — **Wetland deposits** - Peat, muck, silt, and clay. Deposited in poorly drained areas. May be associated with flood-plain alluvium in stream valleys.
- **Qe** — **Eolian deposits** - Windblown sand on the west side of Labrador Brook valley.
- **Pge** — **Esker deposits** - Sand and gravel deposited by glacial meltwater flowing in tunnels within or beneath the ice.
- **Pld** — **Glaciolacustrine delta** - Sand and gravel deposited in an ice-dammed lake in the Bicknell Brook valley.
- **Pm** — **Glaciomarine sediments, undifferentiated** - Sand, gravel, and clay-silt deposited in the late-glacial sea. May include deposits formed in a variety of marine environments and locally modified by postglacial erosion.
- **Pmrs** — **Marine regressive deposits** - Sand and gravel deposited in late-glacial time by ancestral Bog Brook and Bicknell Brook. Graded to falling sea-level in the Hebron Station area.
- **Pp** — **Presumpscot Formation** - Glaciomarine silt, clay, and sand deposited on the late-glacial sea floor.
- **Pmf** — **Glaciomarine fan** - Sand and gravel deposited as a submarine fan at the glacier margin during recession of the late Wisconsinan ice sheet.
- **Pmdl** — **Glaciomarine delta** - Sand and gravel deposited into the sea and built up to the ocean surface. Formed at the glacier margin during recession of the late Wisconsinan ice sheet.
- **Pgi** — **Ice-contact deposits** - Sand and gravel deposited adjacent to glacial ice in the Meadow Brook and Labrador Brook valleys, and at the south end of Lake Auburn. May include esker and glaciomarine fan sediments.
- **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 waterlaid 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.
- **Ice-margin position** - Line shows approximate position of the glacier margin during ice retreat, based on positions of meltwater channels and/or heads of ice-contact deposits.
- **Moraine ridge** - Line shows inferred crest of moraine ridge deposited at the glacier margin.
- **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.
- **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. Dot marks point of observation.
- **Meltwater channel** - Channel eroded by glacial meltwater stream. Arrow shows inferred direction of former stream flow.
- >>>>> **Crest of esker** - Shows trend of esker ridge. Chevrons point in direction of meltwater flow.
- **Area of many large boulders, where observed** - May be more extensive than shown.
- K **Kettle** - Depression created by melting of buried glacial ice and collapse of overlying sediments. Often occupied by ponds (e.g. kettle ponds).
- F **Marine fossil locality** (may be from natural exposure or subsurface core).

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 artificial 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., 2001, Surficial geology of the Lake Auburn West 7.5' quadrangle, Androscoggin and Oxford Counties, Maine: Maine Geological Survey, Open-File Report 01-392, 8 p.
2. Locke, D. B., and Thompson, W. B., 2001, Surficial materials of the Lake Auburn West quadrangle, Maine: Maine Geological Survey, Open-File Map 01-397.
3. Neil, C. N., 1998, Significant sand and gravel aquifers of the Lake Auburn West quadrangle, Maine: Maine Geological Survey, Open-File Map 98-223.
4. Thompson, W. B., 1979, Surficial geology handbook for coastal Maine: Maine Geological Survey, 68 p. (out of print).
5. Thompson, W. B., and Borns, H. W., Jr., 1985, Surficial geologic map of Maine: Maine Geological Survey, scale 1:500,000.
6. Thompson, W. B., Crossen, K. J., Borns, H. W., Jr., and Andersen, B. G., 1989, Glaciomarine deltas of Maine and their relation to late Pleistocene-Holocene crustal movements, *in* Anderson, W. A., and Borns, H. W., Jr. (eds.), Neotectonics of Maine: Maine Geological Survey, Bulletin 40, p. 43-67.

Lake Auburn West Quadrangle, Maine

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Funding for the preparation of this map was provided in part by the U.S. Geological Survey STATEMAP Program, Cooperative Agreement No. 00HQAG0077.

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Open-File No. 08-69
2008

This map supersedes Open-File Map 01-391.

For additional information, see Open-File Report 01-392.

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 (**Figure 8**), 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 Lake Auburn West 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 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 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 (**Figures 3, 4**). 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 13,000 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 (**Figure 2**), in contrast to the chaotic mixture of boulders and sediment of all sizes (till) that was released from dirty ice without subsequent reworking (**Figure 1**). 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 sides of river valleys, such as the Androscoggin and Saco valleys (**Figure 5**). The modern stream network became established soon after deglaciation, and organic deposits began to form in peat bogs, marshes, and swamps (**Figure 6**). 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, since rivers, wave action, and lake ice modify the land (**Figure 7**), and worldwide sea level is gradually rising against Maine's coast.

References Cited

Borns, H. W., Jr., Doner, L. A., Dorion, C. C., Jacobson, G. L., Jr., Kaplan, M. R., Kreutz, K. J., Lowell, T. V., Thompson, W. B., and Weddle, T. K., 2004, The deglaciation of Maine, U.S.A., *in* Ehlers, J., and Gibbard, P. L., eds., Quaternary Glaciations – Extent and Chronology, Part II: North America: Amsterdam, Elsevier, p. 89-109.

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.

Ridge, J. C., 2004, The Quaternary glaciation of western New England with correlations to surrounding areas, *in* Ehlers, J., and Gibbard, P. L., eds., Quaternary Glaciations – Extent and Chronology, Part II: North America: Amsterdam, Elsevier, p. 169-199.

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: Bouldery glacial till exposed in bank next to York Road, Minot.

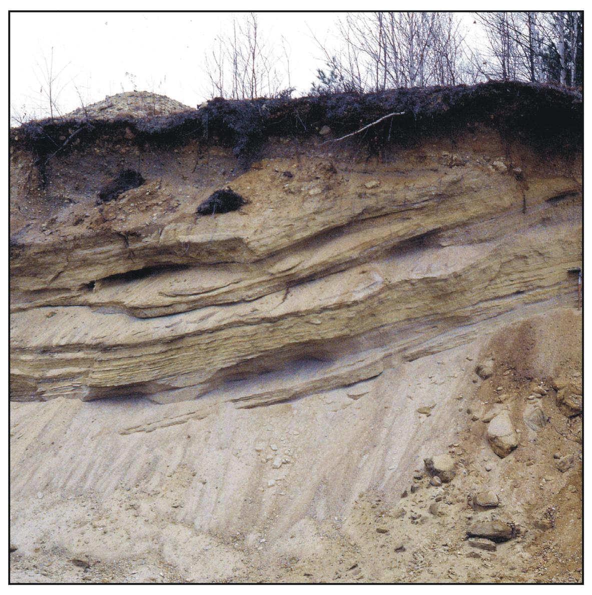

Figure 2: Glacial-lake delta north of Bicknell Brook, Hebron. Contact between upper gravel unit (topset beds) and the inclined sandy foreset beds marks former lake level.

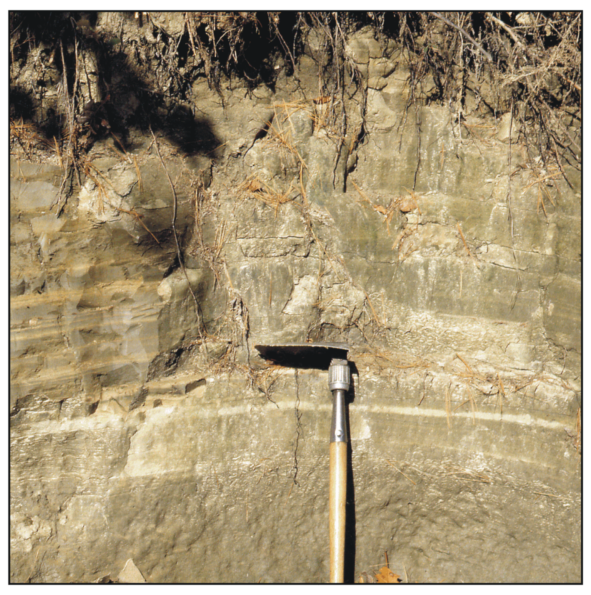

Figure 3: Glaciomarine clay-silt beds (Presumpscot Formation) in shoreline exposure on northeast side of Lake Auburn.

Figure 4: Rills eroded by surface water runoff on exposure of glaciomarine clay-silt in the Nezinscot River valley, Turner.

Figure 5: Eolian sand overlying glaciomarine deltaic sand and gravel, north of Wood Street, Turner.

Figure 6: Wetland in Bog Brook valley north of Hebron Station.

Figure 7: Boulder ridge (ice-push rampart) on northeast shore of Lake Auburn. Produced by modern lake ice.

Figure 8 : Small cave resulting from glacial plucking of steep bedrock slope on east side of Goff Ledge, Minot.