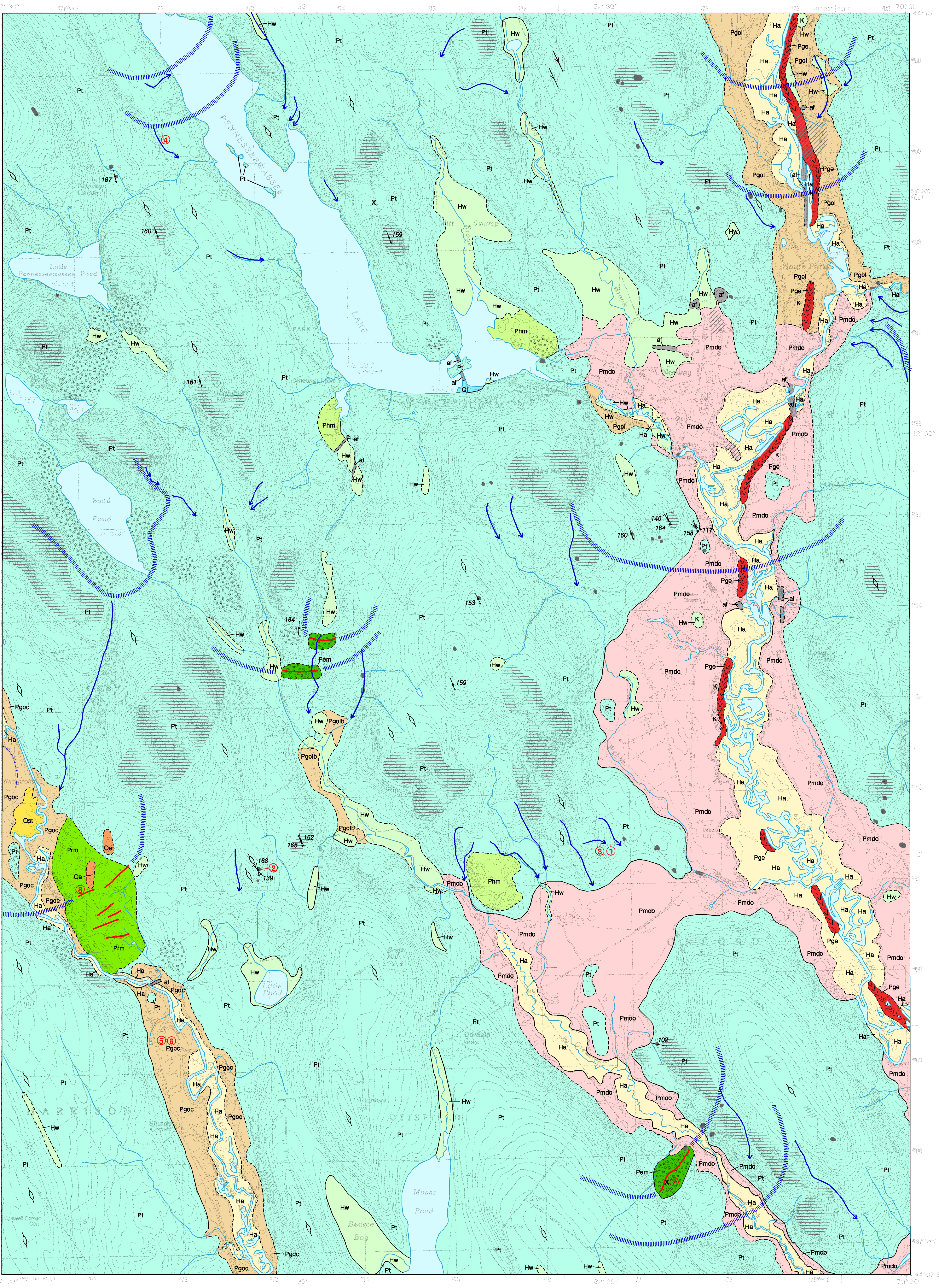
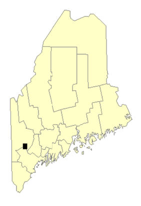
# Surficial Geology




## SOURCES OF INFORMATION

Modified in 2008 based on field work by Woodrow B. Thompson. Surficial geologic mapping by Woodrow B. Thompson completed during the 1999 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 Norway 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. |
| Hw | **Wetland deposits** - Peat, muck, silt, and clay. Deposited in poorly drained areas. |
| Qst | **Stream terrace** - Former flood plain resulting from erosion and downcutting by the Crooked River. |
| Qe | **Eolian deposits** - Windblown sand. Forms dunes and blanket deposits on the sides of the Crooked River valley. |
| Ql | **Lacustrine deposits** - Silt and sand, of possible glaciolacustrine origin, at south end of Pennesseewassee Lake. |
| Pgoc | **Crooked River outwash** - Sand and gravel. Outwash deposited by glacial meltwater streams in the Crooked River valley. |
| Pgolb | **Lombard Brook outwash** - Sand and gravel deposited by glacial meltwater streams in the Lombard Brook valley. |
| Pgol | **Little Androscoggin River outwash** - Sand and gravel deposited by glacial meltwater, including both outwash and ice-contact deposits. Probably deltaic in part. |
| Pmdo | **Glaciomarine delta** - Sand and gravel outwash delta, deposited into the sea in the Little Androscoggin River and adjacent Greenley Brook valleys. Underlain by glaciomarine clay-silt in much of the Little Androscoggin valley. |
| Pge | **Esker deposits** - Sand and gravel deposited by glacial meltwater flowing in tunnels within or beneath the ice. |
| Phm | **Hummocky moraine** - Glacial till with hummocky topography. May contain lenses of sand and gravel. Large boulders commonly present on ground surface. |
| Prm | **Ribbed moraine** - Glacial till with ridge-shaped to hummocky topography. Boulders common on ground surface. |
| Pem | **End moraine** - Till ridge deposit at glacier margin. May include large boulders. |
| 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.

**Modified terrain** - Area where the original topography has been altered by excavation.

af **Artificial fill** - Earth, rock, and/or man-made fill along roads and railroads, and in landfills.

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

**Ice-margin position** - Line shows approximate position of the glacier margin during ice retreat, based on positions of meltwater channels and/or nearby moraine ridges.

**Moraine ridge** - Line shows crest of moraine ridge in area mapped as end moraine or ribbed moraine.

**Scarp** - Hachured line shows scarp carved by stream erosion.

**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. Flagged trend is older.

**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.

X **Large boulder** - Site of large glacially transported boulder.

**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).

④ **Photo locality** - Location of photographed site shown and described in map legend.

**Fluted till** - Narrow ridges of till shaped by glacial ice flow.

## 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. Refer to the list of related publications below.

## OTHER SOURCES OF INFORMATION


1. Thompson, W. B., A., 2000, Surficial geology of the Norway 7.5' quadrangle, Maine: Maine Geological Survey, Open-File Report 00-137.
2. Locke, D. B. and Thompson, W. B., 2000, Surficial materials of the Norway quadrangle, Maine: Maine Geological Survey, Open-File Map 00-132.
3. Neil, C. D., 1998, Significant sand and gravel aquifers of the Norway quadrangle, Maine: Maine Geological Survey, Open-File Map 98-215.
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.
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# Norway Quadrangle, Maine


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**2008**

For additional information, see Open-File Report 00-137
This map supersedes Open-File Map 00-135.


## SURFICIAL GEOLOGY OF MAINE

Continental glaciers similar to the ice sheets in Greenland and Antarctica probably extended across Maine several times during the Pleistocene Epoch, between about 1.5 million and 10,000 years ago. The sediments that cover much of Maine are largely the product of glaciation. Some of these sediments were released directly from the ice, forming deposits of till (**Figure 1**); 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 distribution of glacial sediments in the Norway quadrangle.

The most recent "Ice Age" in Maine began about 30,000 years ago, when an ice sheet originating in Canada 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 caused the land to sink hundreds of feet. Rock debris frozen into the base of the glacier abraded the bedrock surface over which the ice flowed (**Figure 2**). 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. Glacial erosion and sediment deposition combined to give a streamlined shape to many hills, with their long dimension parallel to ice flow. These and other hills may be more-or-less covered by compact glacial sediment (lodgement till) plastered under great pressure beneath the ice (**Figure 3**).

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, 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 northward. Ocean waters extended far up the Androscoggin, Kennebec, and Penobscot valleys, reaching present elevations up to 420 feet in the central part of the state. Ridges of till and/or sand and gravel (end moraines) were formed along successive positions of the retreating ice margin.

Meltwater streams deposited sand and gravel in tunnels within the ice. These deposits remained as ridges (eskers) when the ice disappeared. Maine's esker systems can be traced for up to 100 miles and are among the longest in the country. Sand and gravel accumulated as deltas and submarine fans where the glacier terminated in the sea, while the finer silt and clay dispersed across the ocean floor. Shells of clams, mussels, and other invertebrates are found in the glacial-marine clay (Presumpscot Formation) that blankets the lowlands of southern Maine. Ages of these fossils determined from radiocarbon dating tell us that ocean waters covered parts of Maine until about 11,000 years ago, when rebound of the land surface brought the coastal zone above sea level.

Above and inland from the zone of marine submergence, meltwater flowing off the ice margin carved channels on hillsides (**Figure 4**). 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 (**Figures 5 and 6**). In some places deltas were built into temporary lakes that were dammed by glacial ice or short-lived sediment barriers. Many of these water-laid deposits are well layered and sorted, in contrast to the chaotic mixture of clay, silt, sand, and rocks (till) released from dirty ice without reworking by water. Boulders commonly are scattered across the landscape in till-covered areas (**Figure 7**). End-moraine ridges were constructed along the ice margin where the glacier was still actively flowing and conveying rock debris to its terminus (**Figure 8**), but moraines are not as common in the interior of Maine as in the coastal lowland.

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.

### References Cited


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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:** Glacial till containing a large granite boulder, in borrow pit south of Horse Hill in Norway.

**Figure 2:** Granite ledge (white areas) smoothed by glacial erosion, at Frost Hill waste facility in Norway. Striations at this site record a shift in ice flow direction from southeast to south-southeast.

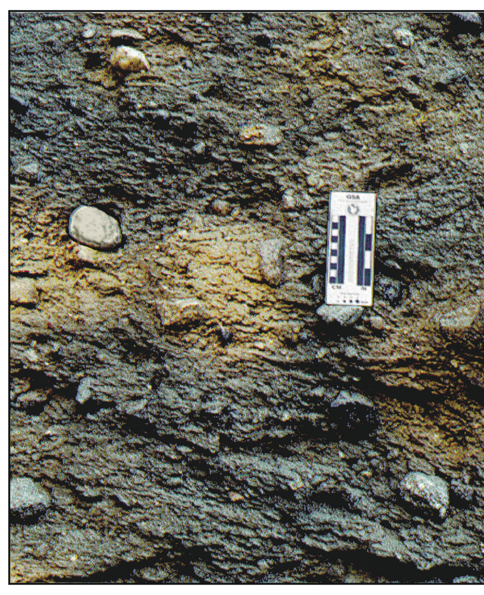

**Figure 3:** Close-up of vertical pit face in lodgement till, south of Horse Hill, showing fissility. Scale card is graduated in inches and centimeters.

**Figure 4:** View north along glacial melwater channel cut in till, east side of Greenwood Road in Norway. The flat, poorly drained channel floor is now a marshy area.

**Figure 5:** Borrow pit in Crooked River outwash plain, Harrison.

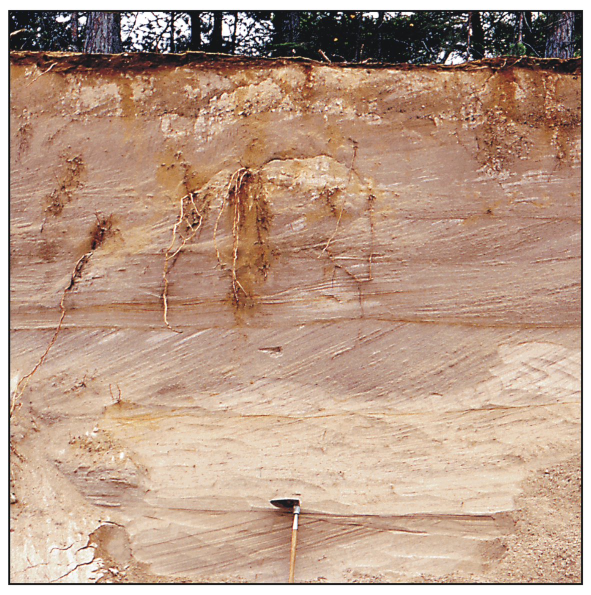

**Figure 6:** Close-up looking west at pit face shown in Figure 5. Photo shows several sets of fluvial cross beds indicating southward flow of glacial meltwater.

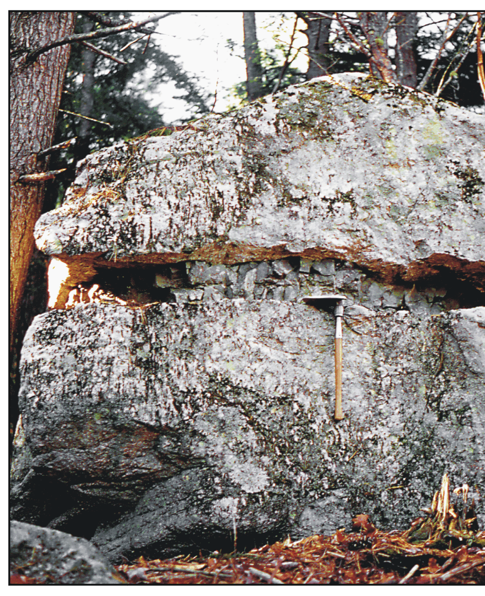

**Figure 7:** This odd glacial boulder is located on the crest of a moraine ridge in the Greenley Brook valley, near Oxford-Otisfield town line. The "sandwich" consists of a weathered basalt dike (center) cutting through granite.

**Figure 8 :** Moraine ridge consisting of bouldery till, east of Crooked River in Norway.