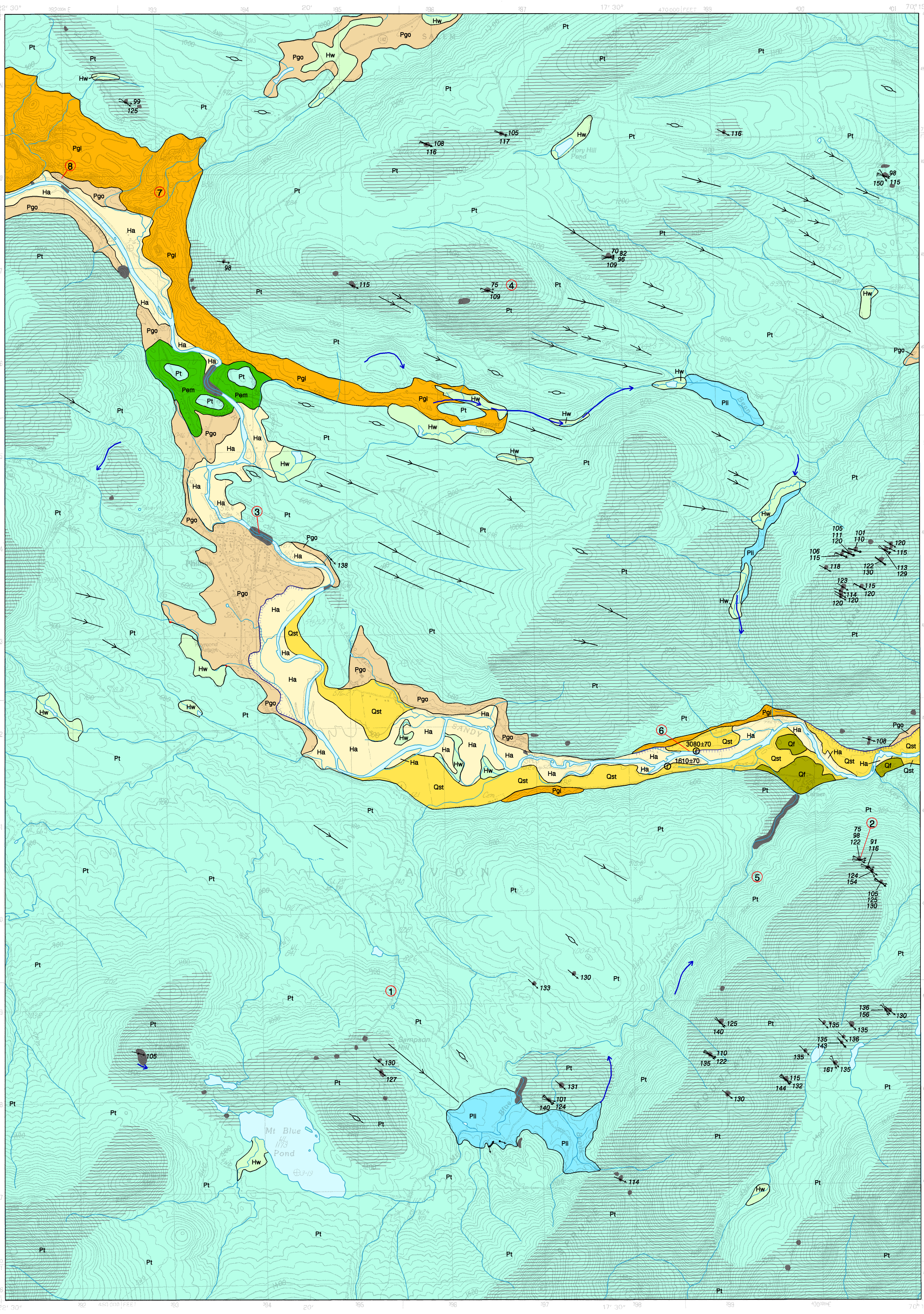
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping by Kent M. Syverson and Rachel M. Greve during the 2002 field season; funding for this work provided by the U.S. Geological Survey STATEMAP program and the Maine Geological Survey, Department of Conservation. Additional data and editing by Thomas K. Weddle from field work conducted in 1990 and 2003.

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 20 FEET

TRUE NORTH

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

- Ha — **Stream alluvium** - Sand, gravel, silt, and organic sediment. Deposited on flood plains of modern streams. Unit may include some wetland areas.
- Hw — **Wetland sediment** - Peat, muck, silt, and clay. Deposited in poorly drained areas.
- Qf — **Alluvial fan deposit** - Small fan-shaped deposits of variably sorted sand, gravel, and mud built by ephemeral or small streams where they emerge from steep slopes onto flat plains or into swamps.
- Qst — **Stream terrace deposit** - Sand, silt, gravel, and occasional muck on terraces cut into glacial deposits of the Sandy River valley and its tributaries. The highest elevation stream terraces are most likely Pleistocene age and may have had a glacial meltwater source.
- Pgo — **Outwash sediment** - Sand and gravel. Outwash deposited by meltwater streams in gently sloping surfaces above the modern stream flood plains.
- Pgi — **Ice-contact sediment** - Sand and gravel, may be interbedded with sandy silt, commonly displays contorted bedding. Deposited by streams above or adjacent to stagnant ice. Locally collapsed and kettled from the melting of stagnant ice.
- Pli — **Lake sediment** - Sand, gravel, and silt deposited in short-lived ice-dammed lakes. Sand and gravel deposited near the shore, and lake-bottom silt deposited farther from shore.
- Pem — **End moraine complex** - Area of sandy diamicton with numerous boulders on the surface of and adjacent to glacially streamlined hills; the deposit includes stratified sand and gravel in places.
- 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). Solid gray areas show individual outcrops.

- **Contact** - Boundary between map units.
- **Glacially streamlined hill, oval hill** - Symbol shows trend of the long axis, which is parallel to the former ice-flow direction.
- **Flute.** Narrow, glacially streamlined ridge. Symbol shows length and trend of the long axis, which is parallel to the former ice-flow direction. Arrowhead indicates former 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.
- **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 tip of arrow.
- **Meltwater channel** - Channel eroded by glacial meltwater stream. Arrow shows inferred direction of former stream flow.
- **Stream-cut bank** - Scarp caused by river erosion. Hatch marks point to the lower surface.
- 10,150±450 — **Non-marine fossil locality.**
- 4 — **Photo locality.**

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. Syverson, K. M., and Greve, R. M., 2003, Surficial geology of the Phillips 7.5' quadrangle, Franklin County, Maine: Maine Geological Survey, Open-File Report 03-48, 12 p.
2. Locke, D. B., Syverson, K. M., and Greve, R. M., 2003, Surficial materials of the Phillips quadrangle, Maine: Maine Geological Survey, Open-File Map 03-46.
3. Neil, C. D., 2003, Significant sand and gravel aquifers of the Phillips quadrangle, Maine: Maine Geological Survey, Open-File Map 03-55.
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.

Phillips Quadrangle, Maine

Surficial geologic mapping by:
Kent M. Syverson and Rachel M. Greve

Digital cartography by:
Susan S. Tolman

Robert G. Marvinney
State Geologist

Cartographic design and editing by:
Robert D. Tucker

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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

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For additional information, see Open-File Report 03-48

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 Phillips 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.

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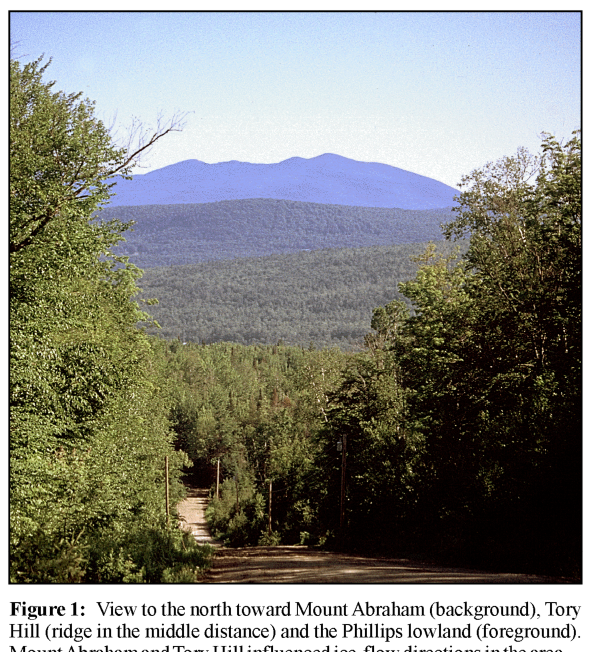

Figure 1: View to the north toward Mount Abraham (background), Tory Hill (ridge in the middle distance) and the Phillips lowland (foreground). Mount Abraham and Tory Hill influenced ice-flow directions in the area.

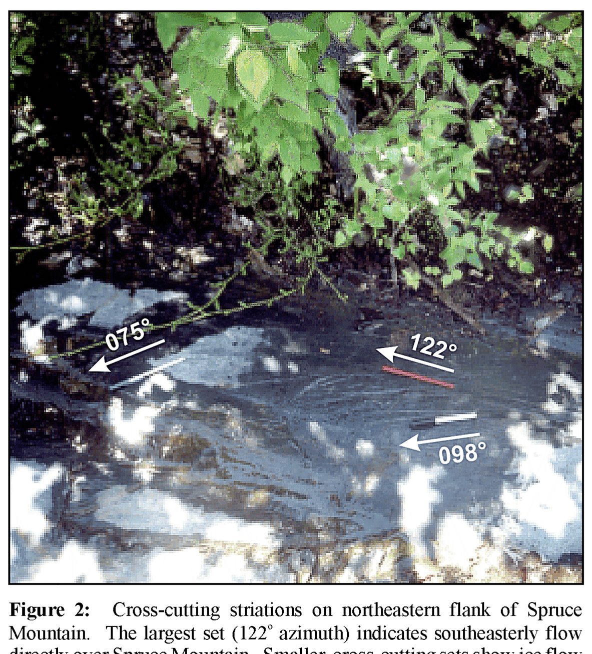

Figure 2: Cross-cutting striations on northeastern flank of Spruce Mountain. The largest set (122° azimuth) indicates southeasterly flow directly over Spruce Mountain. Smaller, cross-cutting sets show ice flow shifting eastward to 98° and finally to 75° as the ice thinned and flow was redirected around Spruce Mountain.

Figure 3: Granitic bedrock of the Phillips pluton in the Sandy River bed northwest of the Highway 149 bridge in Phillips. Cylindrical potholes were abraded by rocks swirling in turbulent water. Bedrock "armors" the bed and limits river erosion.

Figure 4: Dagget Rock, located on Wheeler Hill Road in the northeastern part of the quadrangle, is thought to be the largest glacially transported erratic in the State of Maine. It has split apart since coming to rest *(photo by W. B. Thompson)*.

Figure 5: Ablation till over basal melt-out till on the northern part of Spruce Mountain. The lower, more uniform melt-out till unit was deposited directly by glacier ice and is typical of the glacial till on the Phillips quadrangle. The upper cobble- and boulder-rich sediment melted out on top of the glacier and was sorted by water and gravity processes.

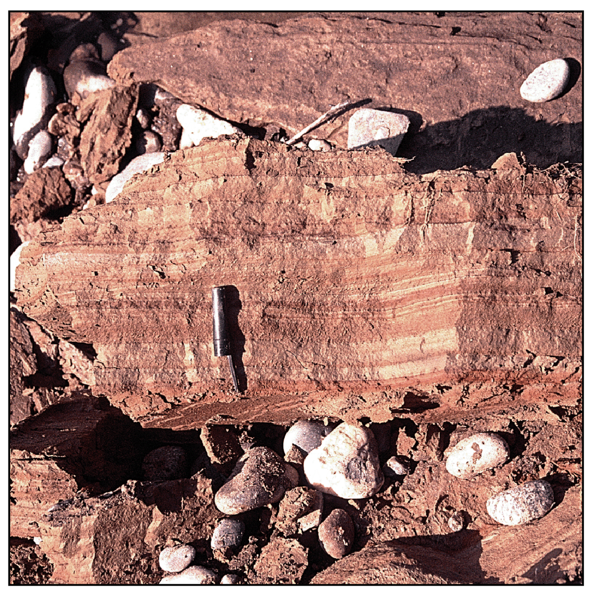

Figure 6: Laminated silt, sand, and clay north of the Sandy River near Avon. Layers with different particle sizes indicate changing water velocities in a lake (or possibly marine) environment. Cap of pen for scale.

Figure 7: Pebble to cobble gravel interbedded with silty sand in gravel pit on Madrid Road, northwestern part of the Phillips quadrangle. Sediment was deposit above and beside glacier ice, and the sediment beds collapsed as the ice melted.

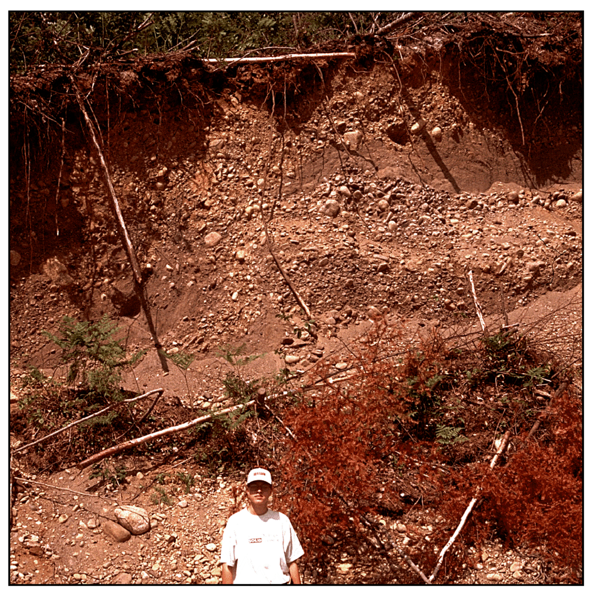

Figure 8: Pebble to cobble gravel and sand deposited adjacent to glacier ice. The gravel pit is located on Madrid Road, northwestern part of the Phillips quadrangle.