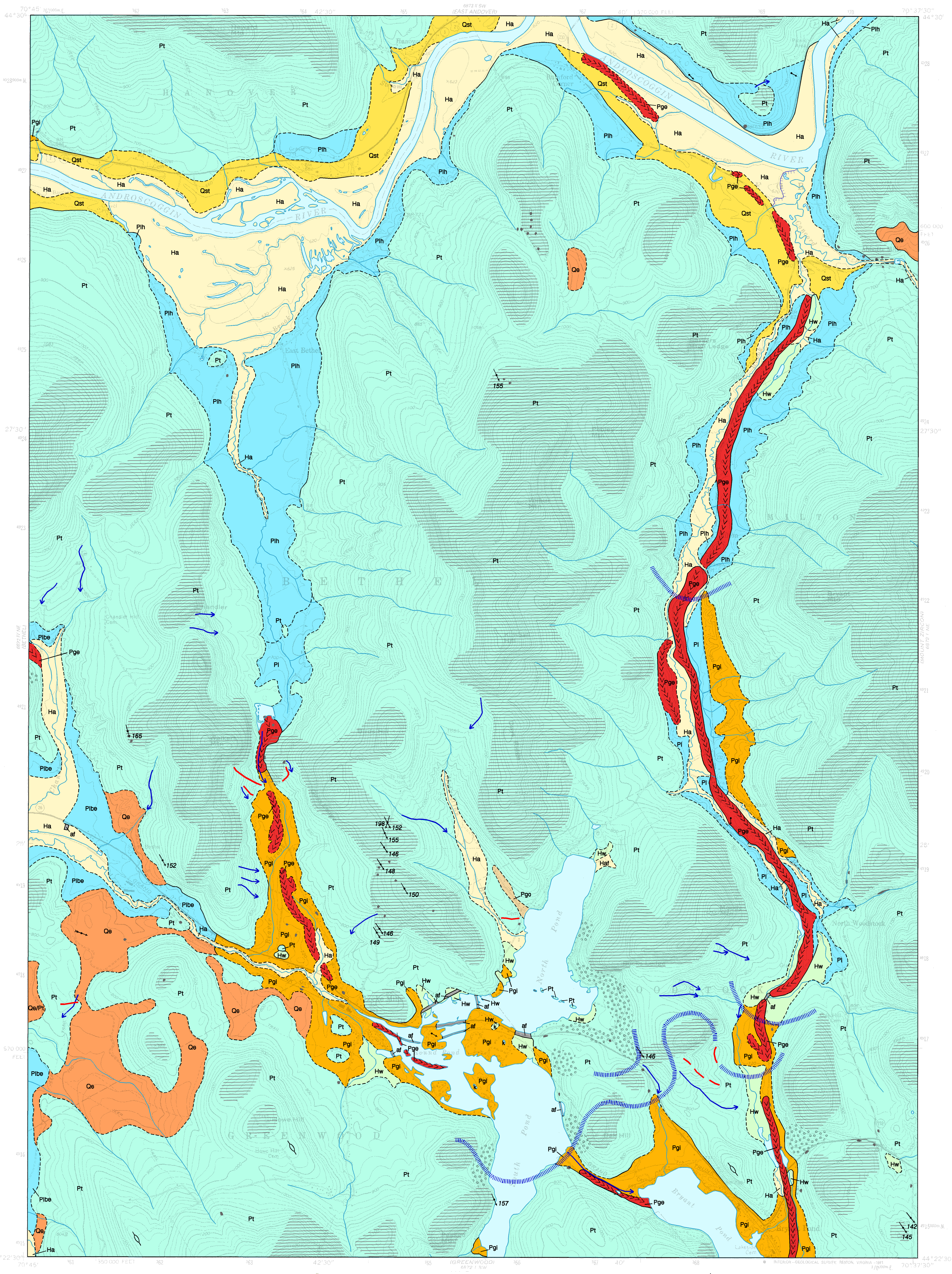
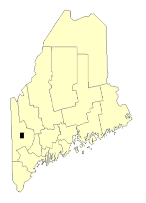
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping of the Bryant Pond 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. Additional editing from fieldwork conducted by W. B. Thompson in 2008.



Quadrangle Location

SCALE 1 : 24,000

CONTOUR INTERVAL 20 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Bryant Pond 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	Description
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.
Haf	**Alluvial fan** - Gravel and sand deposited near the mouth of a small brook that drains into North Pond.
Qst	**Stream terraces** - Extensive sand and gravel terraces occur in the Androscoggin River valley. Formed by postglacial erosion and deposition along the river, and derived in part from reworking of glacial lake sediments.
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.
Qe	**Eolian deposits** - Windblown sand derived from glacial-lake sediments in the Androscoggin River basin. Includes longitudinal dunes oriented parallel to the prevailing wind direction when the dunes formed. Smaller unmapped areas of eolian sand may occur elsewhere in the quadrangle.
Pgo	**Outwash deposits** - Gravel deposited by a glacial meltwater stream in a small valley west of North Pond.
Plbe	**Glacial Lake Bethel deposits** - Sand, gravel, silt, and clay deposited in a glacial lake that occupied the Androscoggin River basin in the southwestern part of the quadrangle. Includes deltaic and fine-grained lake-bottom sediments. The lake level was controlled by one or more spillways at ~690-700 ft elevation in the adjacent Bethel quadrangle.
Plh	**Glacial Lake Hanover deposits** - Sand, gravel, silt, and clay deposited in a glacial lake in the Androscoggin Valley in the northern part of the quadrangle. Includes deltaic and fine-grained lake-bottom sediments, which in many places have been partly eroded by postglacial streams. Glacial Lake Hanover probably was dammed by till deposits that temporarily blocked the narrow portion of the valley beween Rumford Point and Rumford Center. Elevations of Plh deposits suggest a lake level as high as 780 ft.
Pl	**Glacial-lake deposits (undifferentiated)** - Sand and gravel deposited in small ice-dammed lakes in the north sloping Barkers Brook and Otter Brook valleys. Meltwater ponded in the Barkers Brook valley spilled south through a gap at an elevation of about 730 ft between North Woodstock and Bryant Pond. The lake in the Otter Brook valley drained south through a spillway at about 750 ft, east of Walkers Mtn.
Pgi	**Ice-contact deposits** - Miscellaneous sand and gravel deposits formed in contact with remnants of glacial ice. Includes glacial-stream sediments and subaqueous fans built into glacial lakes.
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.
(ruled pattern)	**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.
(scarp symbol)	**Scarp** - Scarp separating adjacent terrace levels in alluvial deposits along the Androscoggin River.
(streamlined hill symbol)	**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.
(red line)	**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. A prominent cross-valley moraine and associated meltwater channels occur in the gap east of Walkers Mtn.
(arrow)	**Dip of cross-bedding** - Arrow shows average dip direction of cross-bedding in sand and gravel deposits formed in a glacial stream or lake. This usually is the direction of meltwater flow (in stream deposits) or the direction in which a delta or subaqueous fan was building into a lake. Dot marks point of observation.
(blue arrow)	**Meltwater channel** - Channel eroded by glacial meltwater stream or outflow from glacial lake. Arrow shows inferred direction of water flow.
>>>>>	**Crest of esker** - Shows trend of esker ridge. Chevrons point in direction of glacial meltwater flow.
k	**Kettle** - "k" indicates a depression left by the melting of a stagnant glacial ice mass.
(hatched blue line)	**Ice-margin position** - Shows an approximate position of the glacier margin during ice retreat, based on meltwater deposits, moraines, and/or positions of meltwater channels.
(circles pattern)	**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.
(arrow)	**Sand dune** - Arrow shows inferred wind direction, based on long axis of longitudinal dune ridge.

Bryant Pond Quadrangle, Maine

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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 Bryant Pond 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. 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 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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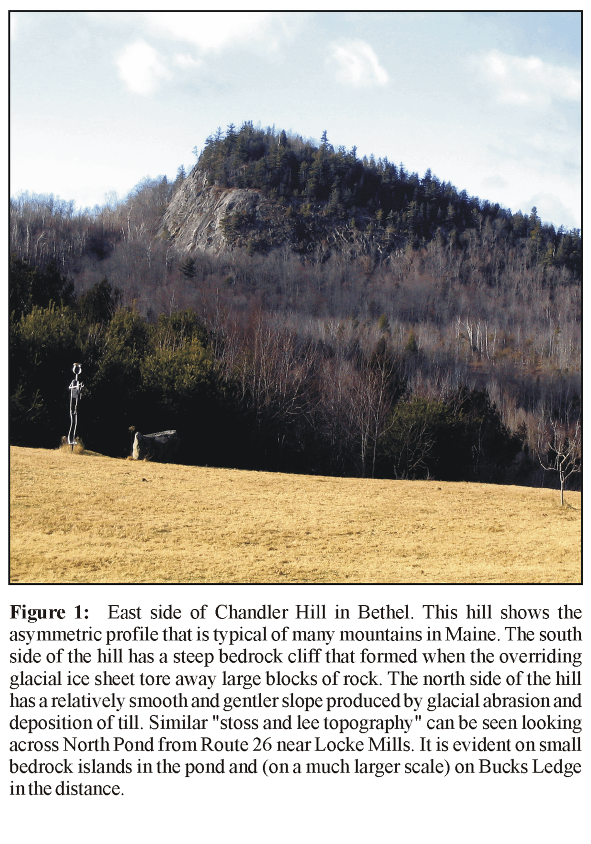

Figure 1: East side of Chandler Hill in Bethel. This hill shows the asymmetric profile that is typical of many mountains in Maine. The south side of the hill has a steep bedrock cliff that formed when the overriding glacial ice sheet tore away large blocks of rock. The north side of the hill has a relatively smooth and gentler slope produced by glacial abrasion and deposition of till. Similar "stoss and lee topography" can be seen looking across North Pond from Route 26 near Locke Mills. It is evident on small bedrock islands in the pond and (on a much larger scale) on Bucks Ledge in the distance.

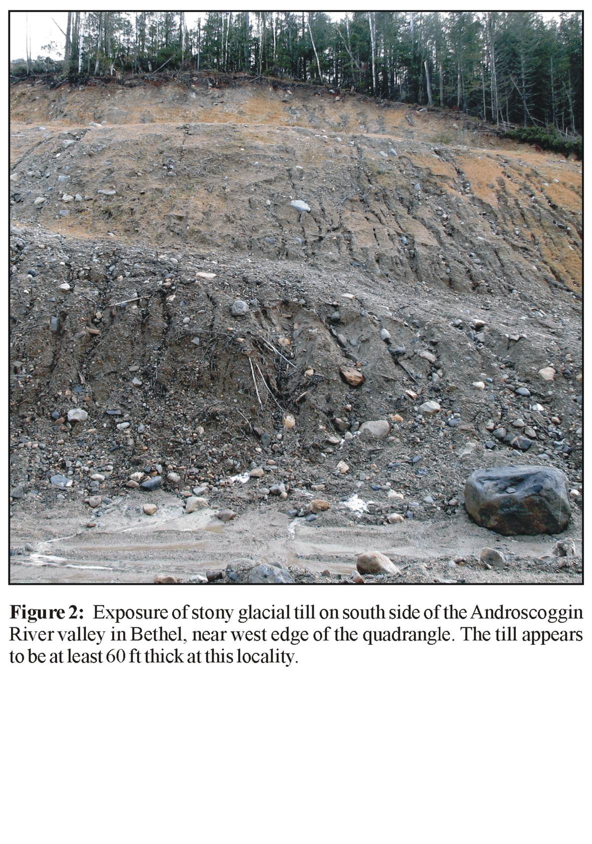

Figure 2: Exposure of stony glacial till on south side of the Androscoggin River valley in Bethel, near west edge of the quadrangle. The till appears to be at least 60 ft thick at this locality.

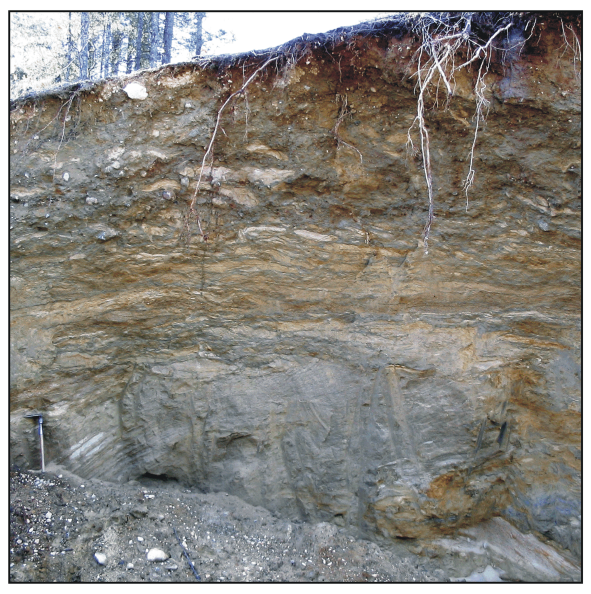

Figure 3: View looking southwest at a pit exposure just north of Cole Hill Cemetery (on Route 232 south of North Woodstock). This unusual section shows glacial till overlying greatly deformed sand and silt. The till is several feet thick and contains small stones (pebble to cobble size) as well as many deformed lenses of light-colored sand. The structure of both the till and sand-silt units indicates pervasive shearing under flowing glacial ice. The sand-silt probably was eroded from glacial-lake sediments just north of here, as the advancing ice margin first dammed a small lake and then overrode sediments that had been deposited in the lake. This pit is located in a ridge that was streamlined by the ice flow.

Figure 4: View looking north at cross-section of esker in Barkers Brook valley, Bethel. The inactive gravel pit seen here is one of many pits in a long esker ridge. This ridge is part of a discontinuous esker system that follows the Androscoggin River and then veers southward through parts of Rumford, Milton, Bethel, and Woodstock. The esker was deposited by a generally south-flowing meltwater stream in a tunnel at the base of the last glacial ice sheet.

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., and Locke, D. B., 2007, Surficial materials of the Bryant Pond quadrangle, Maine: Maine Geological Survey, Open-File Map 07-66.
2. Neil, C. D., 2008, Significant sand and gravel aquifers of the Bryant Pond quadrangle, Maine: Maine Geological Survey, Open-File Map 08-84.
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.

Figure 5: Very coarse boulder gravel in small pit on west side of Rumford Avenue, across the road from Woodstock Elementary School. This is a mound-shaped ice-contact deposit. It is most likely an offshoot of the main esker ridge that is followed by the road.

Figure 6: Windblown sand on hillside south of Rumford Corner, in northern part of the quadrangle. This sand dune most likely formed in early postglacial time, when strong winds eroded glacial lake sediments from the Androscoggin Valley to the west. It was deposited on the sheltered east side of the hill. Soil erosion in historic time has re-exposed the dune sand.

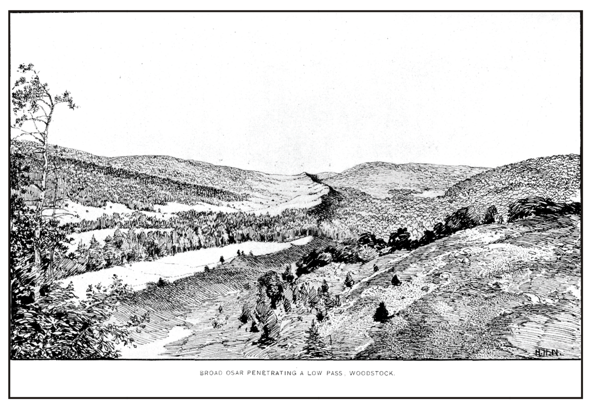

Figure 7: Plate 16 from "The Glacial Gravels of Maine and their Associated Deposits," by George H. Stone (U. S. Geological Survey Monograph 34, 1899). This view looks south along the "osar" (esker) that passes through a gap in the hills at North Woodstock. The picture probably was sketched from a vantage point on a bedrock hill just west of the twin esker ridges shown on the map in Barkers Brook valley.

Figure 8: View from near East Bethel, looking northeast down the Androscoggin River valley. The broad flat area with pools of water is the modern river flood plain.