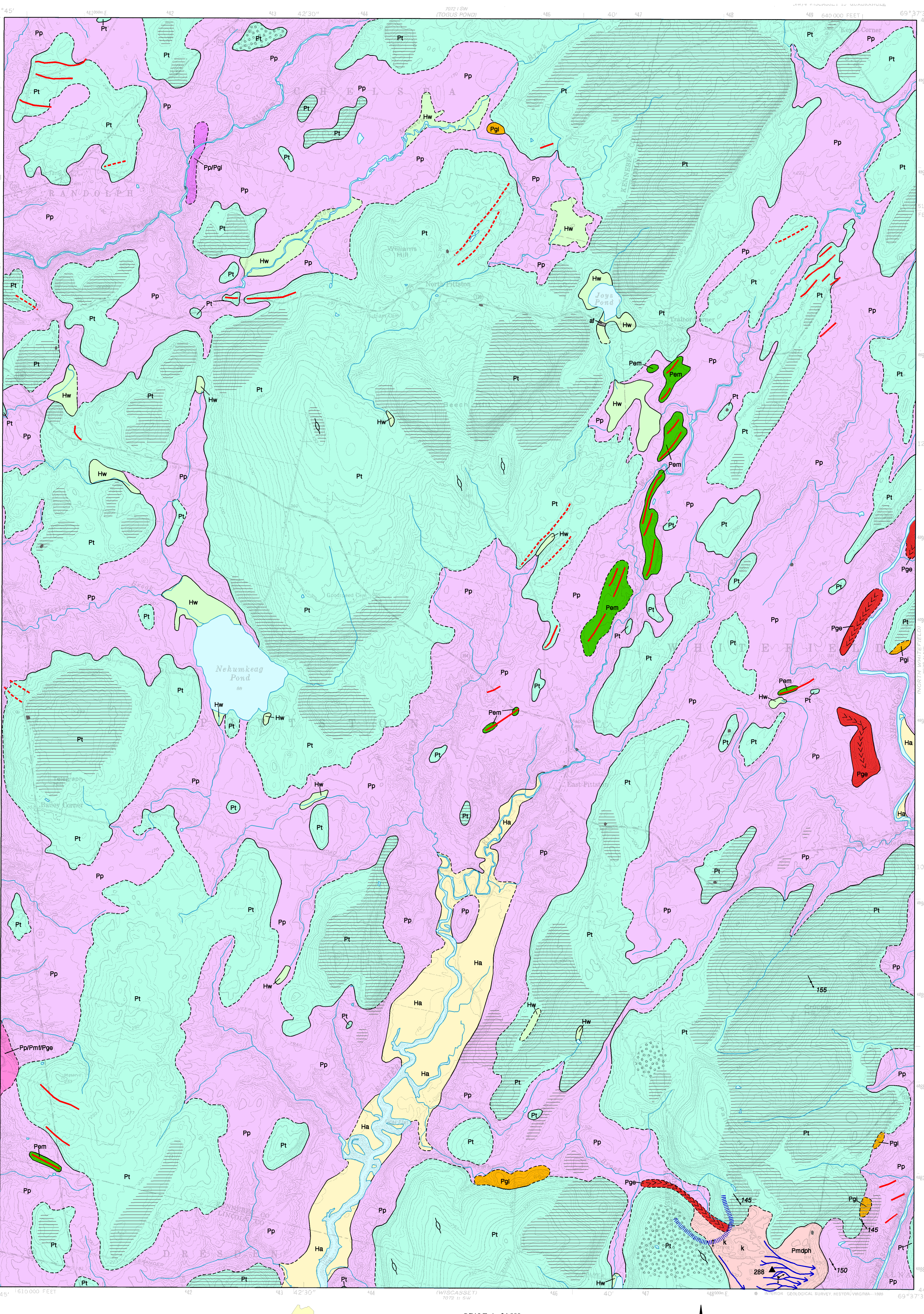
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping of the East Pittston quadrangle was conducted by Woodrow B. Thompson during the 2008 field season. Funding for this work was 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 East Pittston quadrangle, scale 1:24,000 using standard U.S. Geological Survey topographic map symbols.

Ha — **Stream alluvium** - Sand, gravel, and silt deposited on flood plains of the Eastern and Sheepscot Rivers. May include some wetland deposits.

Hw — **Wetland deposits** - Peat, muck, silt, and clay in poorly drained areas. Map unit may include some alluvial sediments along streams.

Pp\Pgi — **Variable thicknesses of glacial-marine silt, clay, and sand (Pp) overlying ice-contact sand and gravel deposits (Pgi) in the Togus Stream valley**. The depositional environments of the ice-contact sediments were not identified, but they are most likely esker or submarine fan deposits.

Pp/Pmf/Pge — **Presumpscot Formation overlying esker and glaciomarine fan deposits.** These deposits form a complex assemblage in the Kennebec River valley, including a small area at the western border of the East Pittston quadrangle. Variable thicknesses of glacial-marine silt, clay, and sand (Pp) overlie sediments that may include esker gravel (Pge) and/or sand and gravel deposited as submarine fans (Pmf). These units could not be distinguished on the map, due to their overlapping relationships and limited fresh exposures.

Pp — **Presumpscot Formation** - Glaciomarine silt, clay, and sand deposited on the late-glacial sea floor. This map unit overlies the irregular surface of glacial till in a complex manner, so it is likely to include areas of till exposed at the ground surface.

Pgi — **Ice-contact deposits** - Miscellaneous sand and gravel deposits formed in contact with glacial ice. This unit may include eskers, submarine fans, and possibly other types of water-laid deposits. Exposures were not numerous or fresh enough to distinguish these types on the map.

Pmdph — **Glaciomarine delta** (Palmer Hill delta) - Sand and gravel deposited into the sea and built up to the ocean surface. Formed at the glacier margin during recession of the most recent (late Wisconsinan) ice sheet. Elevation of boundary between topset and foreset beds (T/F contact) in the delta indicates the position of sea level when the delta was deposited. The T/F contact was surveyed at 287.5 ft (87.6 m) in the Crooker Pit, near the southeast corner of the quadrangle.

Pge — **Esker** - Sand and gravel deposited in part by glacial meltwater flowing in tunnels beneath the ice in the Sheepscot River and Palmer Brook valleys. Chevron symbols show direction of former stream flow. This unit forms a discontinuous series of ridges in the Sheepscot River valley. The sediment deposited in the ice tunnel is typically composed of gravel, which is locally overlain by sand and gravel deposited at the mouth of the tunnel as it migrated during glacial retreat. Younger glacial-marine mud of the Presumpscot Formation likewise drapes over the eskers in places.

Pem — **End moraine** - Ridge(s) formed along the margin of the late Wisconsinan glacial ice sheet during a brief pause in its retreat. Composed of till and/or sand and gravel.

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. This map unit locally includes lenses of water-laid sand and gravel, as well as patches of overlying Presumpscot Formation (Pp). Boulders are commonly scattered across the ground surface.

Bedrock outcrops/thin-drift areas - Ruled pattern indicates areas where bedrock outcrops are common and/or surficial sediments are generally less than 10 ft thick. Mapped from air photos and ground observations. Actual thin-drift areas probably are more extensive than shown. Dots mark locations of individual outcrops.

af — **Artificial fill** - Variable mixtures of earth, rock, and/or man-made materials used as road fill. Usually shown only where large enough to affect the contour pattern on the topographic map.

Contact - Boundary between map units. Many contacts are approximately located and therefore indicated by dashed lines.

Dip of cross-bedding - Arrow shows average dip direction of cross-bedding in glacial sand and gravel deposit. This is the direction of meltwater flow in a stream deposit, or the direction in which a submarine fan was building into the sea. Dot marks point of observation.

▲350 **Glaciomarine delta** - Solid triangle marks site where the elevation of the contact between topset and foreset beds in the Palmer Hill delta was surveyed. See description of unit Pmdph.

Meltwater channel - Channel eroded by glacial meltwater flowing across the top of the Palmer Hill delta (unit Pmdph). Arrow shows direction of stream flow. The channels on the delta formerly were very prominent, but most of them have since been removed by gravel pit operations.

k **Kettle** - Depression formed by melting of glacial ice mass that had been buried in sand and gravel in the Palmer Hill delta (Pmdph).

>>>>> **Axis of esker** - Alignment of symbols shows trend of esker. Chevrons point in direction of former glacial meltwater flow.

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.

Ice margin position. Hachured line shows a temporary position of the receding late Wisconsinan glacier margin. This position was inferred from the ice-contact slope and interlayering of till with sand and gravel in the head of the Palmer Hill delta (Pmdph), as well as meltwater channels originating at the head of the delta.

Moraine ridge - Line shows inferred crest of moraine ridge deposited along the retreating margin of the most recent glacial ice sheet. These moraines are composed mostly of till but may also include sand and gravel and overlapping glacial-marine clay-silt (unit Pp). Dashed where identity is uncertain, including possible moraines mapped from air photos. Moraines in the southwest part of the quadrangle trend NW-SE, indicating faster glacial retreat along the Sheepscot Valley and deflection of ice flow toward the valley axis.

Glacially streamlined hill - Symbol shows long axis of hill or ridge shaped by flow of glacial ice, and which is parallel to former 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 direction. At sites where two sets of striations are present and relative ages could be determined, the flagged arrow indicates the older flow direction.

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., 2009, Surficial materials of the East Pittston quadrangle, Maine: Maine Geological Survey, Open-File Map 09-10.

2. Neil, C. D., 2009, Significant sand and gravel aquifers of the East Pittston quadrangle, Maine: Maine Geological Survey, Open-File Map 09-50.

3. Thompson, W. B., and Borns, H. W., Jr., 1985, Surficial geologic map of Maine: Maine Geological Survey, scale 1:500,000.

4. Newberg, D. W., 1992, Reconnaissance bedrock geology of the East Pittston quadrangle, Maine: Maine Geological Survey, Open-File Map 92-56, scale 1:24,000.

East Pittston 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. 08HQAG0050.

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Open-File No. 09-9
2009
This map supersedes Open-File Map 86-10.

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 East Pittston 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.

References Cited

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INTRODUCTION

The following photos show various sites associated with the Palmer Hill delta (map unit Pmdph) in the southeast corner of the quadrangle. This is one of the most distinctive glacial features in the map area. The weight of the ice sheet pushed the Earth's crust downward, enabling the sea to advance across low-lying areas of southern Maine as the glacier retreated. In many places the sea was in contact with the ice margin, so meltwater streams issuing from tunnels beneath the glacier carried vast quantities of sediments directly into the ocean. The coarser and heavier sediments (sand and gravel) were dumped on the ocean floor right at the ice margin, and they sometimes continued to build up and form large flat-topped deposits called "glacial-marine deltas."

The Palmer Hill delta is an especially good example of the many ice-contact glacial-marine deltas in southern Maine. The ice tunnel that fed the delta eventually filled with gravel, producing a long ridge called an "esker" (map unit Pge) that was revealed when the surrounding ice melted. The glacial stream blasted up under pressure at the head of the delta and flowed southeastward across the delta top, carving a series of shallow channels indicated by the blue arrows on the map. The coarsest gravels were usually deposited in these channels as they migrated across the delta top. The remaining sediments, including a lot of mud, were carried all the way to the front of the delta and into the ocean. Some of this material cascaded down the face of the delta, contributing to its seaward expansion, while the mud suspended in the meltwater plume dispersed farther away and became part of the Presumpscot Formation (map unit Pp) deposited on the sea floor. Because of the way in which these coarse-grained deltas are formed, the final product is a layer of horizontally stratified gravel (the "topset" beds) which has built out over sloping sand-and-gravel beds ("foresets") that accumulated on the delta front. The boundary between topset and foreset beds marks where sea level stood when the delta was deposited. Precise measurement of the elevation of this contact indicated that the former sea level was 288 feet higher than today.

Deltas are important sources of sand and gravel for the construction industry. They also store large amounts of ground water in their deeper portions. The Palmer Hill delta has long been a source of sand and gravel. Gravel pit exposures through the years have provided opportunities to study this deposit in detail. Many of the photos below were taken in the 1980's and 90's, so continued expansion of the pits has removed some of the features shown here.

Figure 1. Prior to glacial retreat, the bedrock surface was abraded by rock debris dragged along under great pressure at the base of the ice sheet. The photo shows parallel glacial grooves on a ledge surface immediately east of the Palmer Hill delta. Coupled with other evidence from nearby areas, the trend of the grooves indicates southeastward ice flow (150°), toward the upper left as seen in this view.

Figure 2. The glacial ice sheet deposited sediment called "till," on top of which the delta formed as the ice melted. This photo shows stratified deltaic sand (top) overlying gray stony till exposed in the floor of a gravel pit.

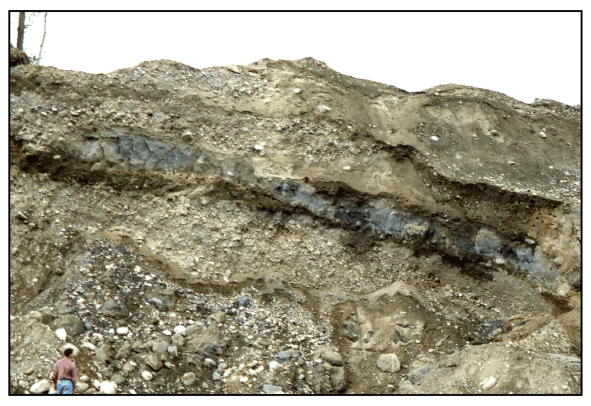

Figure 3. Till (gray layer seen in pit face) was interstratified with coarse ice-contact gravel near the head (northwest margin) of the Palmer Hill delta. The till probably slumped off the glacier. Numerous exposures of till lenses and till clasts in this part of the delta, along with deformed bedding and depressions (kettle holes) left by melting ice, indicated that the deposit formed at the edge of the ice sheet.

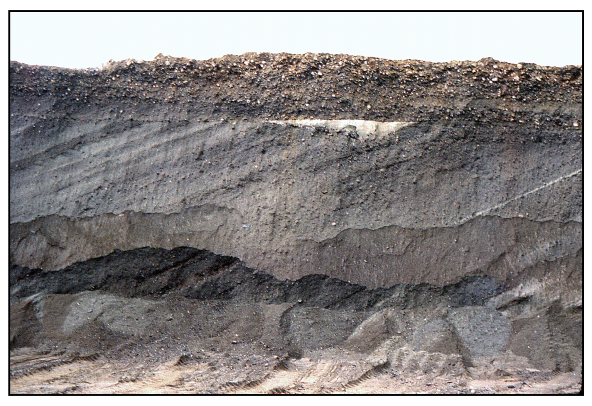

Figure 4. View looking southwest at a pit face showing the contact between horizontal topset beds and inclined foreset beds in the Palmer Hill delta. This contact marks the level of the ocean surface when the delta was deposited.

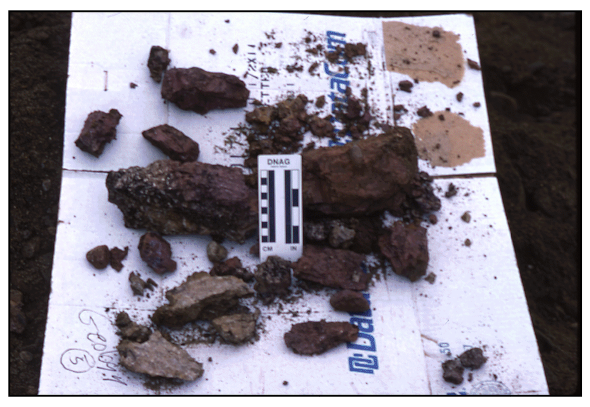

Figure 5. In 1988, an equipment operator at the Crooker Pit called attention to these chunks of mottled reddish-brown and tan clay which had been found in the topset gravel beds of Palmer Hill delta. Analysis by Joseph Kelley (University of Maine) revealed that this material is a clay mineral called kaolinite, which is rare in Maine and normally found in non-glaciated southern states where rock weathering has continued for millions of years. The most plausible explanation for this occurrence is that pieces of the clay were picked up by the subglacial stream that fed the delta and washed out onto the delta surface. Some of the sticky clay managed to hold together during this turbulent trip, and the fresh well-rounded pebbles found in the clay may have been rolled into it from the surrounding gravel. A possible source for the clay is a bedrock fault zone that crosses the Palmer Brook valley northwest of the delta. The bedrock on both sides of the fault is granitic and could have weathered preglacially to leave a kaolinite residue (Newberg, 1992).

Figure 6. Front (southeast) side of Palmer Hill delta, just south of the quadrangle border. Maine's sandy deltas are extensively used for growing blueberries, whose leaves turn brilliant red in the fall. Springs are common on the frontal "toe" of these deltas, including the low forested area seen here. They occur where ground water flows down through the permeable sand and gravel and then hits a low-permeability material such as marine clay and flows laterally out to the delta front.

Figure 7. In the same area shown in Figure 6, a low beach ridge occurs along Ben Bailey Road on the southeast margin of the delta top. This view looks southwest along the beach crest. The ridge is composed of gravel and rises slightly higher than the delta surface seen near the right-center edge of the photo.

Figure 8. A recent (2008) view of Palmer Hill delta foreset beds exposed in the Crooker Pit. This exposure is near the terminus of the northernmost meltwater channel shown on the map. The delta top apparently was washed by ocean waves in this area, forming the well-stratified pebble gravel on top of the foreset beds. This horizontal gravel unit resembles topset beds, but is finer-grained and slightly lower than the topsets in a nearby part of the same pit.