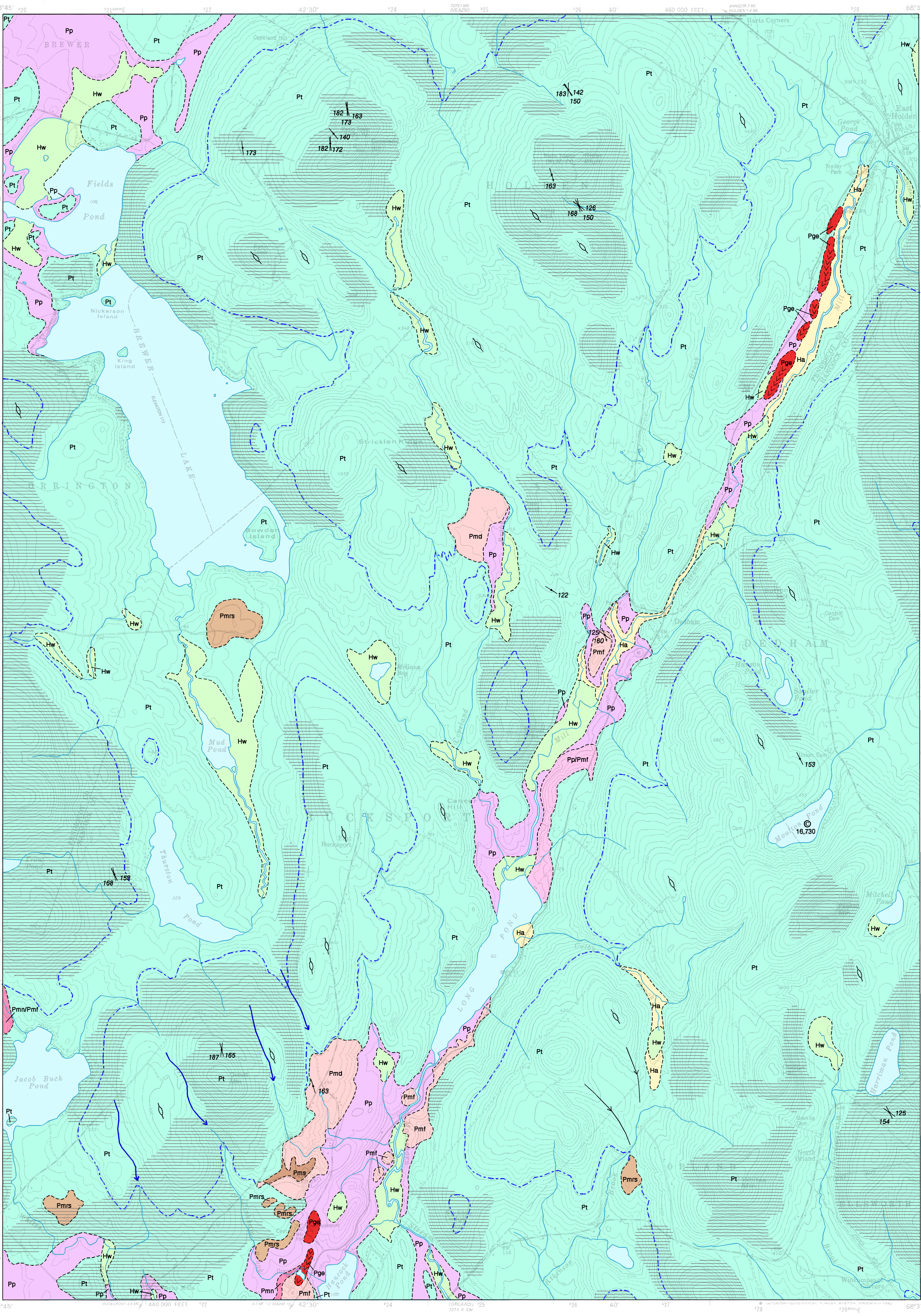
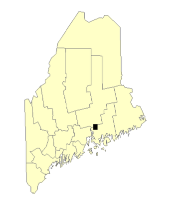
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping of the Brewer Lake quadrangle was conducted by Alice R. Kelley and Lynn Caron in 2010 for the STATEMAP program.



Quadrangle Location

SCALE 1 : 24,000

CONTOUR INTERVAL 20 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Brewer Lake 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.

Brewer Lake 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 (**Figure 1**), eroding and transporting boulders and other rock debris for miles (**Figure 2**). 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 Brewer Lake 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 (**Figure 3**). 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 (**Figure 4**) 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 (**Figure 5**). 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 (**Figure 6**).

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 (**Figure 7**). 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 (**Figure 8**), and worldwide sea level is gradually rising against Maine's coast.

References Cited

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Figure 1: "The Bubbles" and Jordan Pond in Acadia National Park. These hills and valleys were sculpted by glacial erosion. The pond was dammed behind a moraine ridge during retreat of the ice sheet.

Figure 2: Daggett's Rock in Phillips. This is the largest known glacially transported boulder in Maine. It is about 100 feet long and estimated to weigh 8,000 tons.

Figure 3: Granite ledge in Westbrook, showing polished and grooved surface resulting from glacial abrasion. The grooves and shape of the ledge indicate ice flow toward the southeast.

Figure 4: Glaciomarine delta in Franklin, formed by sand and gravel washing into the ocean from the glacier margin. The flat delta top marks approximate former sea level. Kettle hole in foreground was left by melting of ice.

Figure 5: Esker cutting across Kezar Five Ponds, Waterford. The ridge consists of sand and gravel deposited by meltwater flowing in a tunnel beneath glacial ice.

Figure 6: Aerial view of moraine ridges in blueberry field, Sedgwick (note dirt road in upper right for scale). Each bouldery ridge marks a position of the retreating glacier margin. The ice receded from right to left.

Figure 7: Sand dune in Wayne. This and other "deserts" in Maine formed as windstorms in late-glacial time blew sand out of valleys, often depositing it as dune fields on hillsides downwind. Some dunes were reactivated in historical time when grazing animals stripped the vegetation cover.

Figure 8: Songo River delta and Songo Beach, Sebago Lake State Park, Naples. These deposits are typical of geological features formed in Maine since the Ice Age.

Explanation

Symbol	Description
Ha	**Stream alluvium** - Sand, gravel, and silt deposited on flood plains of modern streams.
Hw	**Fresh water wetland deposits** - Peat, muck floored by silt and clay. Deposited in poorly drained areas on valley floors. Unit may grade into or include areas of stream alluvium.
Pmrs	**Marine regressive deposits** - Sand, gravel, and silt deposited in (or graded to) shallow marine waters during late-glacial regression of the sea. Includes large sand plains that commonly overlie marine mud of the Presumpscot Formation. Formed by a variety of fluvial and nearshore processes.
Pms	**Marine shoreline deposits** - Beach and dune deposits ranging from sand to gravel. Formed during the regressive phase of late-glacial marine submergence.
Pmn	**Marine nearshore deposits** - Sand, gravel, and silt deposited by wave and current action in shoreline and shallow nearshore environments. Formed mostly during the regressive phase of late-glacial marine submergence. May be very thin in areas of bedrock-controlled topography.
Pmn/Pmf	**Glaciomarine nearshore deposits overlying glaciomarine fan sediment** - Massive to stratified and cross-stratified sand, silt, and minor gravel (Pmn) overlying submarine fan sediment (Pmf) containing well stratified sand and gravel.
Pmd	**Glaciomarine delta** - Sand and gravel deposited into the sea and built up to the ocean surface. Commonly displays larger foreset beds and features such as faults and soft-sediment folding. Formed at the glacier margin during recession of the late Wisconsinan ice sheet.
Pmf	**Glaciomarine fans** - Sand and gravel deposited as submarine fans. Frequently associated with eskers.
Pp	**Presumpscot Formation** - Fine-grained marine silt and clay. Surface has characteristic gullied appearance.
Pp/Pmf	**Presumpscot Formation overlying glaciomarine fan sediment** - Glaciomarine silt, clay, and sand (Pp) overlying submarine fan sediment (Pmf) containing well stratified sand and gravel.
Pge	**Eskers** - Sand and gravel deposited in tunnels in ice sheet. Esker deposits in this region draped with fine-grained glaciomarine deposits.
Pt	**Till** - Loose to compact and poorly sorted, matrix supported to weakly stratified clay, silt, sand, and gravel. Boulders may be present on surface. Upper portions of till deposits are brown and weakly stratified as a result of regressive marine phase. Matrix in areas dominated by metasedimentary rocks have a clay-rich matrix, while till associated with areas of granite outcrop have a sand-rich matrix. Covered with colluvium in some areas.
(ruled pattern)	**Thin drift areas** - Ruled pattern indicates area where outcrops are common and/or surficial sediments are generally less than 10 ft thick. Thin drift is more extensive than shown, particularly on topographic highs.
(dashed line)	**Contact** - Boundary between map units. Dashed where approximately located.
(symbol)	**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.
(symbol)	**Glacially grooved or fluted till** - Formed beneath the glacier by erosion of till surfaces by boulders in the base of the ice scouring the till, or by obstructions on the till surface that allow for development of elongate till ridges parallel to ice-flow direction.
135, 180	**Glacial striation locality** - Dot marks point of observation. Number is azimuth (in degrees) of flow direction. At sites where two or more sets of striations are present and relative ages could be determined, the flagged trends indicate the older flow directions.
135, 180	**Crag and tail** - Dot marks point of observation. Number is azimuth (in degrees) of ice-flow direction. Flagged trends indicate older flow directions.
(blue arrow)	**Direction of meltwater or meteoric water flow** - Channel eroded by glacial meltwater stream or postglacial stream. Arrow shows inferred direction of water flow.
>>>>>	**Esker crest** - Chevron points in inferred direction of glacial meltwater flow.
(blue dashed line)	**Upper limit of marine submergence** - Shows highest elevation of sea level immediately following recession of the last glacial ice sheet from the quadrangle.
16,730 ©	**Calibrated radiocarbon date locality.** Dated sample is organic material from a sediment core obtained from Moulton Pond. Original laboratory age is 13,510±300 radiocarbon years before present (Davis and others, 1975). Calibrated age is 16,730 calendar years, with a 95.4% (2 sigma) probability range of 17,130 - 15,210 years, based on IntCal09 calibration data from Reimer and others (2009).

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 drained 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

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