

Surficial Geology

Lincolnville 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 to 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 Lincolnville 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.

References Cited

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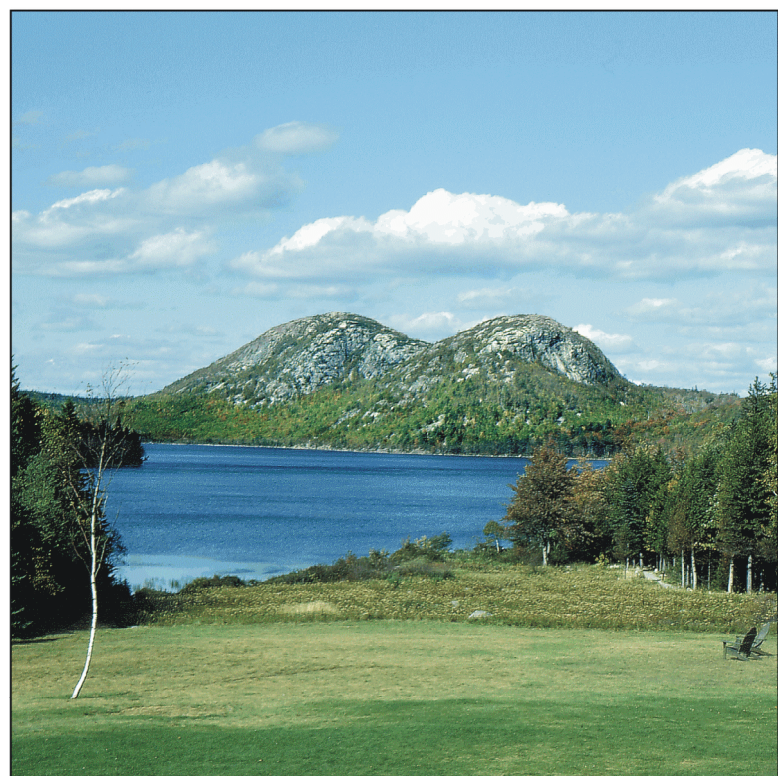


Figure 1: "The Bubbles" and Jordan Pond in Acadia National Park. These hills and valleys were sculpted by glacial erosion. The pond was dammed behind a moraine ridge during retreat of the ice sheet.



Figure 2: Dagget'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.

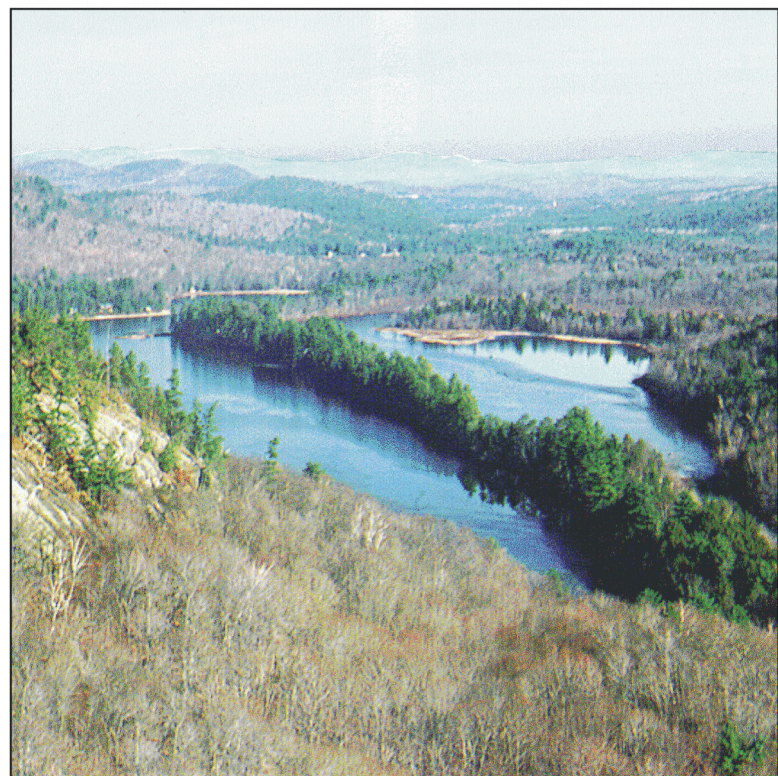


Figure 5: Esker cutting across Kezar Five Ponds, Watford. The ridge consists of sand and gravel deposited by meltwater flowing in a tunnel beneath glacial ice.



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 blow 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.



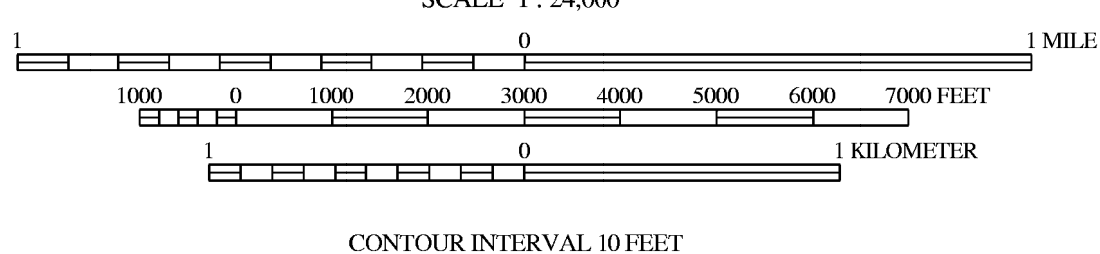
Figure 8: Songo River delta and Songo Beach, Sebago Lake State Park, Naples. These deposits are typical of glacial features formed in Maine since the Ice Age.

SOURCES OF INFORMATION

Surficial geologic mapping of the Lincolnville quadrangle was conducted by Thomas K. Weddle during the 2012 field season. Funding for this work was provided by the U. S. Geological Survey STATEMAP program and the Maine Geological Survey, Department of Agriculture, Conservation and Forestry.



Quadrangle Location



CONTOUR INTERVAL 10 FEET



Topographic base from U.S. Geological Survey Lincolnville 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 implicate responsibility for any present or potential effects on the natural resources.

- Hw** Wetland deposits - Peat, muck, silt, and clay in poorly drained areas. Map unit may also include some alluvial sediments along stream valleys.
- Hms** Marine shoreline deposits - Sand and gravel on modern ocean beaches.
- Pg** Pleistocene deposits of uncertain origin - Sand and gravel that was deposited in contact with glacial ice and/or resulted from marine wave action as relative sea-level fell in late-glacial time. Exposures were not numerous or fresh enough to determine the origin of these deposits.
- Pp** Presumpscot Formation - Glaciomarine silt, clay, and sand deposited on the sea floor during marine submergence of coastal lowlands in late-glacial time. This map unit commonly 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.
- Phm** Hummocky moraine - Comprised of thick diamiction, in places 20 to 75 feet thick based on water well data. Interpretation also based in part on LiDAR imagery showing hummocky surface.
- 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. Boulders are commonly scattered across the ground surface. Till in the Lincolnville Quadrangle reaches a thickness of 127 ft or more. This map unit locally includes sand and gravel developed along former marine shorelines, as well as patches of overlying Presumpscot Formation (unit Pp).
- Ptd** Thin drift, undifferentiated - Areas of thin patchy sediment cover on bedrock, which are unmapped or have few exposures of surficial materials. The sediments may include till, Presumpscot Formation, and/or marine nearshore deposits.
- 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 ground observations, air photos, and LiDAR (Light Detection And Ranging) imagery. Actual thin-drift areas probably are more extensive than shown.
- af** Artificial fill - Variable mixtures of earth, rock, and/or man-made materials used as fill for roads. Usually shown only where large enough to affect the contour pattern on the topographic map.

- Contact** - Boundary between map units. Most contacts are approximately located and therefore indicated by dashed lines.
- Marine regressive shoreline** - Line indicates a former shoreline formed in late-glacial time, when relative sea level was higher than today. Mapped from LiDAR imagery.
- Upper limit of marine submergence** - Shows highest elevation of sea level immediately following recession of the last glacial ice sheet from the quadrangle.
- Moraine ridge** - Line shows crest of moraine ridge deposited along the retreating margin of the most recent glacial ice sheet. Composed of till and/or sand and gravel, 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.
- Glacially streamlined feature** - Symbol shows long axis of hill or ridge shaped by flow of glacial ice, and which is parallel to former ice-flow direction. Includes drumlins and streamlined features with fluted topography.
- 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. Where striation sets of different ages are present, the flagged arrow indicates the older set.
- Meltwater channel** - Channel eroded by glacial meltwater stream. Arrow shows inferred direction of water 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

- Weddle T. K., and others, 2013, Surficial materials of the Lincolnville quadrangle, Maine: Maine Geological Survey, Open-File Map 13-6.
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