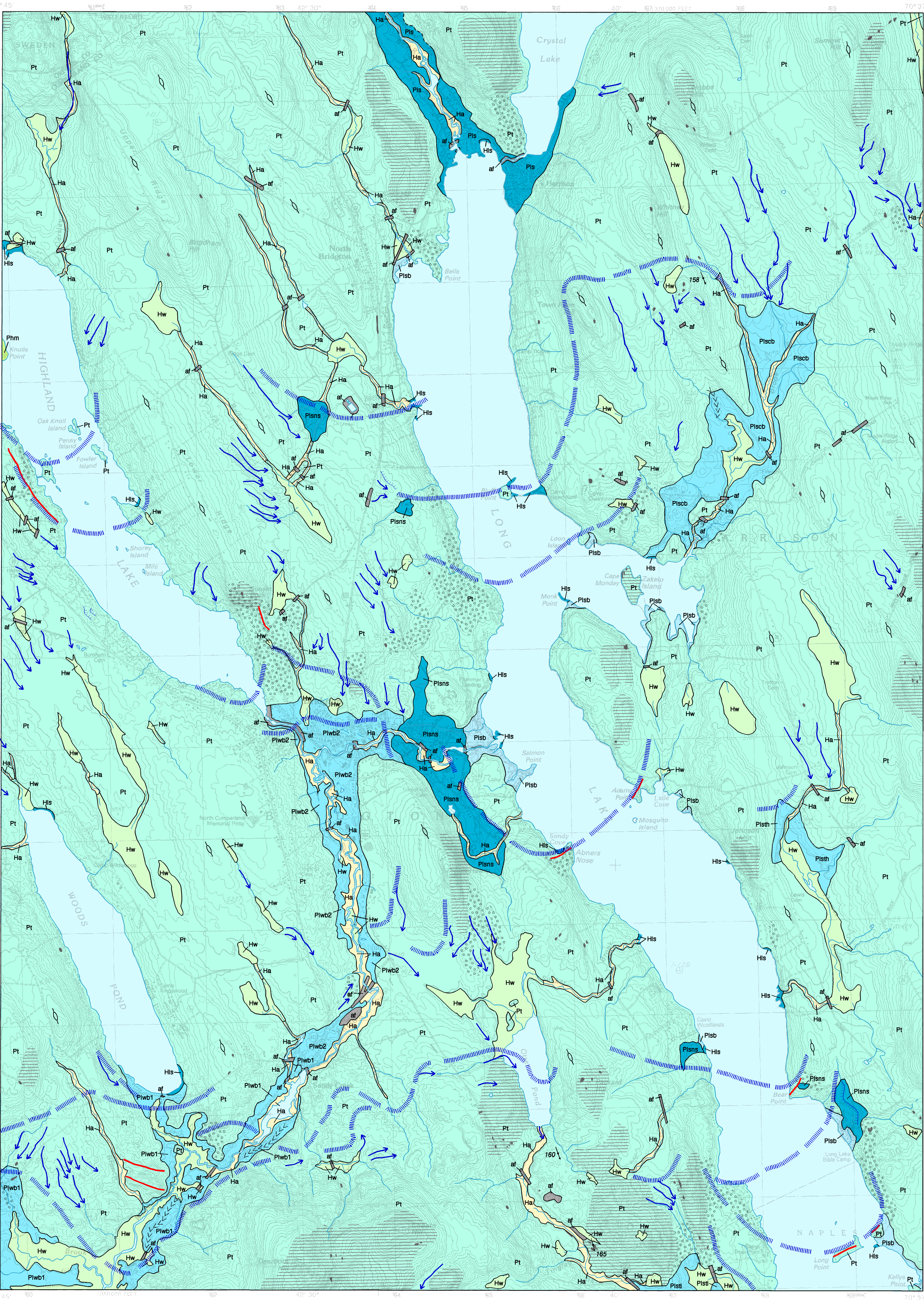
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping of the Bridgton quadrangle was conducted by Carol T. Hildreth during the 1999 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

CONTOUR INTERVAL 10 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Bridgton 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.

NOTE: A very thin, discontinuous layer of windblown sand and silt, generally mixed with underlying glacial deposits by frost action and bioturbation, is present near the ground surface over much of the map area but is not shown.

af — **Artificial fill** - Man-made. Material varies from natural sand and gravel to quarry waste to sanitary landfill; includes highway and railroad embankments and dredge spoil areas. This material is mapped only where it can be identified using the topographic contour lines. Minor artificial fill is present in virtually all developed areas of the quadrangle. Thickness of fill varies.

Ha — **Stream alluvium** (Holocene) - Sand, silt, gravel, and muck in flood plains along present rivers and streams. As much as 3 m (10 ft) thick. Extent of alluvium indicates most areas flooded in the past that may be subject to future flooding. In places, this unit is indistinguishable from, grades into, or is interbedded with freshwater wetlands deposits (Hw), especially in the Willett* Brook flood plain.

Hw — **Freshwater wetland deposit** (Holocene) - Muck, peat, silt, and sand. Generally 0.5 to 3 m (1 to 10 ft) thick. In places, this unit is indistinguishable from, grades into, or is interbedded with stream alluvium (Ha), especially in the Willett* Brook flood plain.

Hls — **Modern beach deposit** - Sand and/or gravel with silt in places. Developed along the present and prehistoric shorelines of lakes and ponds. Most extensive and thickest on larger lakes; 0.5 to 2 m (1 to 6 ft) thick. Includes spit deposits and may include dune deposits.

Pls — **Glaciofluvial and glaciolacustrine deposits of the Bear River-Crystal Lake area** (Pleistocene) - Sand, gravel, silt, and mud. Consists of undifferentiated outwash, bottom, and shore deposits of glacial Lake Sebago. Thickness varies; generally 0.5-21 m (1-69 ft) thick.

Plsns — **Glacial Lake Sebago shoreline and nearshore deposits** (Pleistocene) - Sand, gravel, silt, and mud. Consists of undifferentiated deltaic, ice-contact, fan, beach and nearshore deposits formed in relatively shallow water by wave action reworking older glacial deposits. Some deposits have features characteristic of shallow-water environments. Thickness varies from less than 0.5 m to more than 7 m (1-20 ft).

Plsb — **Glacial Lake Sebago bottom deposit** (Pleistocene) - Massive to stratified and cross-stratified sand (generally fine- to medium-grained) and massive to laminated silt and silty clay. Locally may contain boulders, sand, and gravel. Found as a blanket deposit over bedrock and older glacial sediments. Deposited at bottom of glacial Lake Sebago during late-glacial time. Deposits of this unit occupy the lowest elevations in the quadrangle, including deposits under Long Lake. Variable thickness, generally 0.5-9 m (1-30 ft).

Plscb — **Glaciofluvial and glaciolacustrine deposits of the Carlsley Brook area** (Pleistocene) - Sand, gravel, silt, and mud. Consists of undifferentiated ice-contact, outwash, bottom, and shore deposits of glacial Lake Sebago. Thickness varies; generally 0.5-3 m (1-10 ft) thick.

Plsth — **Glaciofluvial and glaciolacustrine deposits of the Thames Brook area** (Pleistocene) - Sand, gravel, silt, and mud. Consists of undifferentiated ice-contact, outwash, bottom, and shore deposits of glacial Lake Sebago. Thickness varies; generally 0.5-3 m (1-10 ft) thick.

Plwb2 — **Glaciofluvial and glaciolacustrine deposits (second stage) of the Willett* Brook area** (Pleistocene) - Sand, gravel, silt, and mud. Consists of undifferentiated ice-contact, outwash, bottom, and shore deposits of glacial Lake Willett* Brook. Graded to an outlet at about 125 m (410 ft) elevation near the intersection of Route 117 and 302, whence meltwaters flowed southeast toward Otter Pond and the headwaters of Tingley Brook, the valley of which in the Bridgton quadrangle was carved into a relatively deep gorge by these meltwaters. Thickness varies; generally 0.5-11 m (1-35 ft) thick.

Plwb1 — **Glaciofluvial and glaciolacustrine deposits (first stage) of the Willett* Brook area** (Pleistocene) - Sand, gravel, silt, and mud. Consists of undifferentiated ice-contact, outwash, bottom, and shore deposits of Glacial Lake Willett* Brook. Graded first to a divide between the headwaters of the brook and Perley Pond, between 159 and 165 m (521 and 540 ft) elevation, about 3.2 m (2 mi) south of the quadrangle; later to various cols in this quadrangle in the hills to the east at 152-158 m (500-520 ft) elevation. Thickness varies; generally 0.5-17m (1-55 ft) thick.

Plsti — **Glaciofluvial and glaciolacustrine deposits of the Tingley Brook area** (Pleistocene) - Sand, gravel, silt, and mud. Consists of undifferentiated ice-contact, outwash, bottom, and shore deposits of glacial Lake Sebago. Thickness varies; generally 0-11m (1-35 ft) thick.

Phm — **Hummocky moraine** - Glacial till with hummocky topography. Consists of poorly sorted rock debris deposited by glacial ice. May contain variable proportions of sand and gravel. Locally very bouldery.

Pt — **Till** (Pleistocene) - Light- to dark-gray, nonsorted to poorly sorted mixture of clay, silt, sand, pebbles, cobbles, and boulders; a predominantly sandy diamicton containing some washed sand and gravel. Thickness varies and generally is less than 6 m (20 ft), but is probably more than 30 m (100 ft) under many drumlins and streamlined hills. Many streamlined hills in this area are bedrock-cored.

* mislabeled as "Willis" Brook on the Bridgton topographic map.

Bedrock exposures. Not all individual outcrops are shown on the map. Gray dots indicate individual outcrops; ruled pattern indicates areas of abundant exposures and areas where surficial deposits are generally less than 3 m (10 ft) thick. Mapped in part from aerial photography, soil surveys (Hedstrom, 1974), and previous geologic maps (Thompson, 1977).

Contact - Boundary between map units. Dashed where very approximate.

Scarp — A relatively steep and straight slope, inferred to be formed by wave action (erosional).

Direction of glacial meltwater or meteoric water flow over outwash or till deposit.

135 — Glacial striation. Point of observation is at dot. Number is azimuth (in degrees) of former ice flow direction.

Drumlin form or other glacially streamlined hill. Symbol indicates general direction of glacial ice movement.

>>>>> — Crest of esker or ice-channel filling. Shows trend of sand and gravel ridge deposited in meltwater tunnel within or beneath glacier. Chevrons point in inferred direction of former meltwater flow.

Area of many large boulders.

Moraine ridge. Ridge of till and/or waterlaid sediments interpreted to have formed in marginal zone of glacier.

Inferred approximate ice-frontal position at time of deposition of meltwater deposits.

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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.

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Bridgton Quadrangle, Maine

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For additional information, see Open-File Report 00-139.
This map supersedes Open-File Map 00-138.

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 Bridgton 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.

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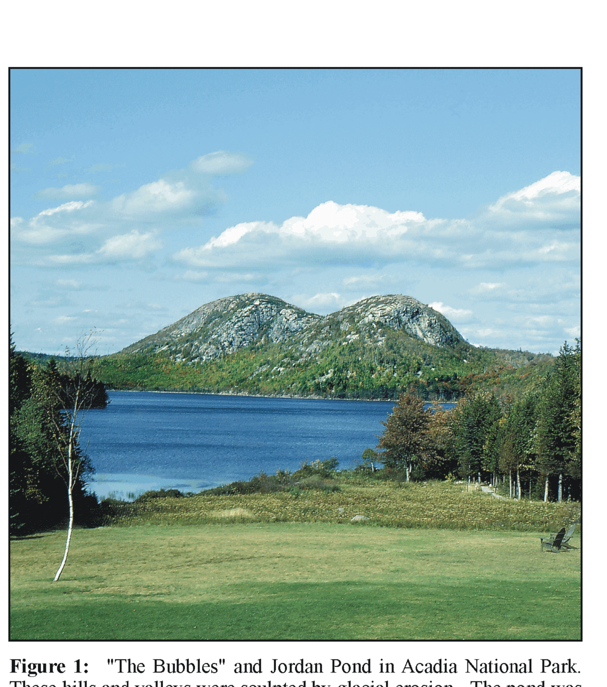

Figure 1: "The Bubbles" and Jordan Pond in Acadia National Park. These hills and valleys were sculpted by glacial erosion. The pond was dammed behind a moraine ridge during retreat of the ice sheet.

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.