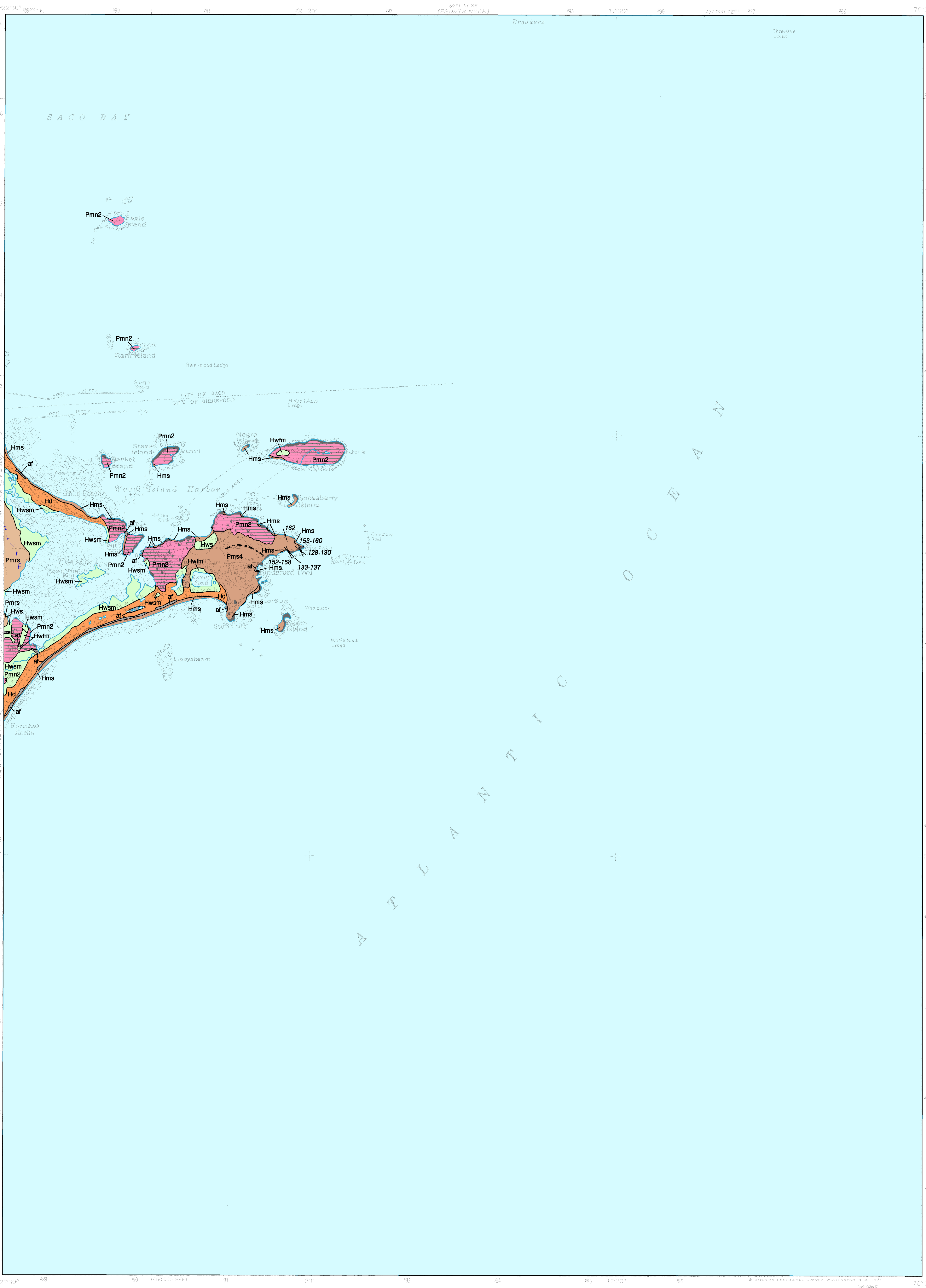
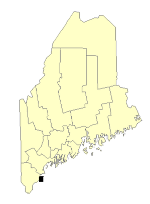
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping by Carol T. Hildreth completed during the 1987 field season; funding for this work provided by the U. S. Geological Survey COGEOMAP program. Wetlands data provided in part by Cornelia C. Cameron, U.S. Geological Survey, 1988. Geologic unit designations and contacts revised and matched to adjacent quadrangles in 1999 by MGS geologists.



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 20 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Biddeford Pool 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.

af — **Artificial fill** - Artificially emplaced materials of nearly any composition, man-made or natural; areas filled may be either man-made or natural depressions; includes dumps, landfills and areas where the surface has been so altered by construction that the natural landscape has been obliterated -- such as in city centers. Thickness variable.

Hws — **Wetland, swamp** - Peat, silt, clay, and sand. Poorly drained area with variable tree cover, often with standing water. Thickness variable.

Hwfm — **Wetland, freshwater marsh** - Peat, silt, clay, and sand. Poorly drained freshwater grassland, often with standing water and cattails. Thickness variable.

Hwsm — **Wetland, salt marsh** - Peat, silt, clay, and sand. Coastal marsh subject to tidal flooding and containing salt marsh grasses, 0.5 to 2 m thick; where 1 m or more thick, bottom part commonly peat rich.

Hms — **Marine shoreline deposit** (beach) - Sand and/or gravel, and minor silt. Developed along the present coast. 0.5 to 5 m thick. May include sand dunes in places.

Hd — **Sand dunes** - Sand with minor silt and gravel in places. Developed primarily along the present shoreline as part of barrier beach complexes, but two small deposits were found inland. 0.5 to 5 m thick.

Pmn_2 — **Marine nearshore deposits** - Thin, discontinuous deposits of sand, gravel, silt-clay, and reworked till overlying bedrock and till. Formed in shallow marine waters where glacial sediments were reworked by ocean waves and currents during regressive phase of late-glacial marine submergence. Average thickness probably less than 2 m. Subdivided into units 1 and 2 on the basis of elevation [Pmn_1 is above the 120- foot sea level stand of unit Pms_2 in the Biddeford quadrangle, and Pmn_2 is below that level.]

Pms_4 — **Marine shoreline deposits** - Predominantly sand and gravel. Consists of beach deposits formed during stillstands of relative sea level in regressive phase of marine submergence. Thickness variable, less that 3 m to more than 10 m. Pms_1 represents deposits that accumulated at stands of 160+ and 140+ ft, combined. Pms_2, a stand of 120- ft; Pms_3, combined stands of 80+ and 60+ ft; and Pms_4, a sea-level stand of 40- ft. Pms_{1-3} are mapped in the Biddeford quadrangle.

Pmrs — **Marine regressive sand deposits** - Massive to stratified and cross-stratified, well-sorted sand. Generally has gradational basal contact with Pp. Thickness 0.5 to 5 m. Deposited during regressive phase of marine submergence.

Bedrock - Rock units not distinguished. Individual outcrops not shown in areas of poor access. Ruled pattern indicates areas where surficial materials are thin (less than 1-2 m) and bedrock exposures are abundant. Areas of bedrock exposure (gray areas) are mapped in part from direct observation and in part from aerial photos.

Sedimentary scarp - Scarp within the marine regressive sand deposits.

Contact

Marine strandline - Defined by beach or base of wave-cut cliff.

135 — **Glacial striation** - Includes striations, grooves, crag-and-tails and related ice-flow indicators on bedrock outcrops. Dot or center of arrow is point of observation. Arrowhead omitted where ice-flow direction is unknown. Flag indicates older trend. Number indicates azimuth of ice-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. Hildreth, C. T., 1999, Surficial geology of the Biddeford Pool 7.5-minute quadrangle, York County, Maine: Maine Geological Survey, Open-File Report 99-110, 10 p.
2. Hildreth, C. T., 1999, Surficial materials of the Biddeford Pool quadrangle, Maine: Maine Geological Survey, Open-File Map 99-43.
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.
5. Thompson, W. B., Crossen, K. J., Borns, H. W., Jr., and Andersen, B. G., 1989, Glaciomarine deltas of Maine and their relation to late Pleistocene-Holocene crustal movements, *in* Anderson, W. A., and Borns, H. W., Jr. (eds.), Neotectonics of Maine: Maine Geological Survey, Bulletin 40, p. 43-67.

Biddeford Pool Quadrangle, Maine

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Funding for the preparation of this map was provided in part by the U.S. Geological Survey Cooperative Geological Mapping (COGEOMAP) Program, Cooperative Agreement No. 14-08-0001-A0381.

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Open-File No. 99-79
1999

For additional information, see Open-File Report 99-110.

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 Biddeford Pool quadrangle.

The most recent "Ice Age" in Maine began about 25,000 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 years ago, soon after it reached its southernmost position on Long Island (Sirkin, 1986). The edge of the glacier withdrew from the continental shelf east of Long Island and reached the present position of the Maine coast by 13,800 years ago (Dorion, 1993). 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. 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 (**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 10,000 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

Davis, R. B., and Jacobson, G. L., Jr., 1985, Late-glacial and early Holocene landscapes in northern New England and adjacent areas of Canada: Quaternary Research, v. 23, p. 341-368.

Dorion, C. C., 1993, A chronology of deglaciation and accompanying marine transgression in Maine: Geological Society of America, Abstracts with Programs, v. 25, no. 2, p. 12.

Sirkin, L., 1986, Pleistocene stratigraphy of Long Island, New York, *in* Caldwell, D. W. (editor), The Wisconsinan stage of the first geological district, eastern New York: New York State Museum, Bull. 455, p. 6-21.

Stone, B. D., and Borns, H. W., Jr., 1986, Pleistocene glacial and interglacial stratigraphy of New England, Long Island, and adjacent Georges Bank and Gulf of Maine, *in* Sibrava, V., Bowen, D. Q., and Richmond, G. M. (editors), Quaternary glaciations in the northern hemisphere: Quaternary Science Reviews, v. 5, p. 39-52.

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.