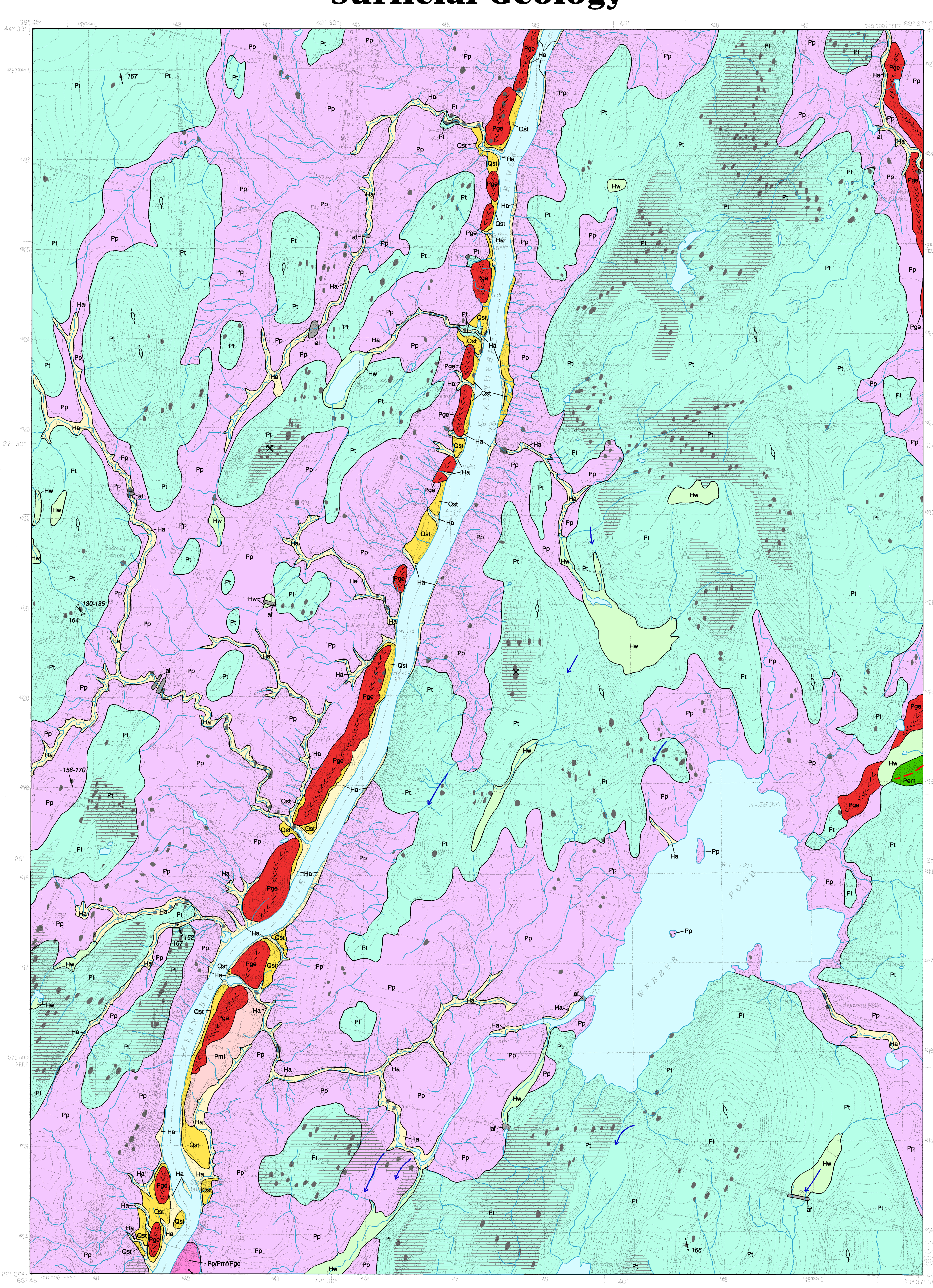
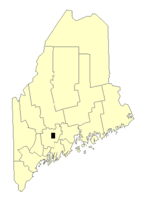
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping of the Vassalboro quadrangle was conducted by Carol T. Hildreth during the 2004 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 Vassalboro quadrangle, scale 1:24,000 using standard U.S. Geological Survey topographic map symbols.

af	**Artificial fill** - Man-made. Material may range from natural sand and gravel to quarry waste or sanitary landfill, including highway and railroad embankments. This material is mapped only where it can be identified using the topographic contour lines or where actually observed. 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 the unit is indistinguishable from, grades into, or is interbedded with wetlands deposits (Hw).
Hw	**Freshwater wetland deposits** (Holocene) - Muck, peat, silt, and sand deposited in poorly drained areas. Generally 0.5 to 3 m (1 to 10 feet) thick, but may be much thicker in large bogs. In places, this unit is indistinguishable from, grades into, or is interbedded with stream alluvium (Ha).
Qst	**Stream terrace deposits** (Holocene and Late Pleistocene) - Sand, silt, gravel and occasional muck on terraces cut into glacial deposits in the Kennebec River valley. These deposits are the lowest recognizable terraces in the valley and were formed in part during late-glacial time as sea level regressed; they are also the lowest fluvial terraces in the quadrangle. From 0.5 to 6m (1 to 20 ft) thick.
Pge	**Eskers and/or ice-channel fillings** (Pleistocene) - Mostly gravel and sand, deposited by meltwater streams in tunnels within or beneath glacial ice (eskers) or in narrow fissures in the ice that were open to the sky at the time of deposition (ice-channel fillings). Chevrons aligned along crest of esker point in direction of inferred meltwater flow. Thickness varies from 0 to over 30 m (0-100 ft). May be overlain locally by sandy to gravelly marine fan deposits, or by glaciomarine mud of the Presumpscot Formation.
Pmf	**Marine fan deposits** (Pleistocene) - Variably sorted and stratified sand, gravel, and silt. Deposited into the sea at the margin of the most recent glacial ice sheet as it retreated from southern Maine. These deposits were laid down where meltwater streams issued from the mouths of glacial ice tunnels. May contain kettle holes and overlie older esker deposits. Thickness varies from 0 to over 30 m (0-100 ft).
Pp	**Presumpscot Formation: glaciomarine bottom deposits** (Pleistocene) - Silt and clay with local sand beds. Consists mostly of fine-grained (muddy) sediments deposited on the sea floor in late-glacial time. May overlie or be interbedded with unit Pmf and Pmd. As much as 21 meters (70 feet) thick.
Pp/Pmf/ Pge	**Presumpscot Formation overlying earlier glacial meltwater deposits** (Pleistocene) - Area in which Kennebec Valley esker deposits (Pge) are associated with overlying marine fan sediments (Pmf) and both of these units are draped by silt and clay of the Presumpscot Formation.
Pem	**End moraine** (Pleistocene) - Ridge of till deposited at the glacier margin. May include boulders and lenses of sand and gravel.
Pt	**Till** (Pleistocene) - Light- to dark-gray, poorly sorted mixture of clay, silt, sand, pebbles, cobbles, and boulders; a predominantly sandy diamicton containing some gravel. Generally underlies most other glacial and postglacial deposits. Thickness varies and generally is less than 6 m (20 ft) but may be more than 30 m (100 ft) under some drumlins and streamlined hills. Many streamlined hills in this area are bedrock-cored.

Bedrock exposures/thin drift areas - Not all outcrops are shown on the map. Gray dots indicate individual outcrops; ruled pattern indicates areas of abundant bedrock exposure and/or areas where surficial deposits are generally less than 3 m (10 ft) thick. Mapped in part from aerial photography; soil surveys (Faust and LaFlamme, 1978); previous geologic maps (Osberg, 1968; Prescott, 1969; Thompson, 1977 and 1987; and Thompson and Borns, 1985); significant sand and gravel aquifer maps (Neil and Locke, 1999); and materials maps (Locke, 1999).

Contact - Boundary between units, approximately located.

Meltwater channel - Channel eroded by glacial meltwater or later meteoric runoff.

135 **Glacial striation** - Point of observation is at dot. Arrow shows ice-flow direction inferred from striations on bedrock. Number is azimuth (in degrees) of flow direction. Where two striation directions are present, the older set is indicated by flagged arrow.

Drumlin or other glacially streamlined hill - Symbol is parallel to general direction of glacial ice movement.

Current direction within stratified water-laid deposits - Measurement taken at tip of arrow.

End moraine - Dashed line indicates crest of probable end moraine ridge, which formed by sediment accumulation along a glacial ice margin.

>>>>> **Esker crest** - Chevron points in inferred direction of meltwater flow.

Rock quarry.

REFERENCES

Faust, A. P., and LaFlamme, K. J., 1978, Soil survey of Kennebec County, Maine: U.S. Dept. Agriculture, Soil Conservation Service, 87 p., scale 1:20,000.

Locke, D. B., 1999, Surficial materials of the Vassalboro quadrangle, Maine: Maine Geological Survey, Open-File Map 99-69, scale 1:24,000.

Neil, C. D., and Locke, D. B., 1999, Significant sand and gravel aquifers of the Vassalboro quadrangle, Maine: Maine Geological Survey, Open-File Map 99-31.

Osberg, P. H., 1968, Stratigraphy, structural geology, and metamorphism of the Waterville-Vassalboro area, Maine: Maine Geological Survey, Bulletin 20, 64 p., map.

Prescott, G. C., Jr., 1969, Groundwater favorability areas and surficial geology of the lower Kennebec River basin, Maine: U.S. Geological Survey, Hydrologic Investigations Atlas HA-337, scale 1:62,500.

Thompson, W. B., 1977, Reconnaissance surficial geology of the Vassalboro quadrangle, Maine: Maine Geological Survey, Open-File Map 77-35, scale 1:62,500.

Thompson, W. B., compiler, 1987, Surficial geology of the Bangor 1° x 2° quadrangle, Maine: Maine Geological Survey, Open-File Map 87-9, scale 1:250,000.

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

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., and Locke, D. B., 2004, Surficial materials of the Vassalboro quadrangle, Maine: Maine Geological Survey, Open-File Map 05-9.
2. Neil, C. D., 1999, Significant sand and gravel aquifers of the Vassalboro quadrangle, Maine: Maine Geological Survey, Open-File Map 99-31.
3. Thompson, W. B., 1979, Surficial geology handbook for coastal Maine: Maine Geological Survey, 68 p. (out of print).

Vassalboro Quadrangle, Maine

Surficial geologic mapping by

Carol T. Hildreth

Digital cartography by: Robert A. Johnston

Robert G. Marvinney, *State Geologist*

Cartographic design and editing by: Robert D. Tucker

Funding for the preparation of this map was provided in part by the U.S. Geological Survey STATEMAP Program, Cooperative Agreement No. 04HQAG0035.

DEPARTMENT OF CONSERVATION MAINE

Maine Geological Survey

Address: 22 State House Station, Augusta, Maine 04333
Telephone: 207-287-2801 **E-mail:** mgs@maine.gov
Home page: http://www.maine.gov/doc/nrimc/nrimc.htm

Open-File No. 05-8
2005

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 Vassalboro 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.