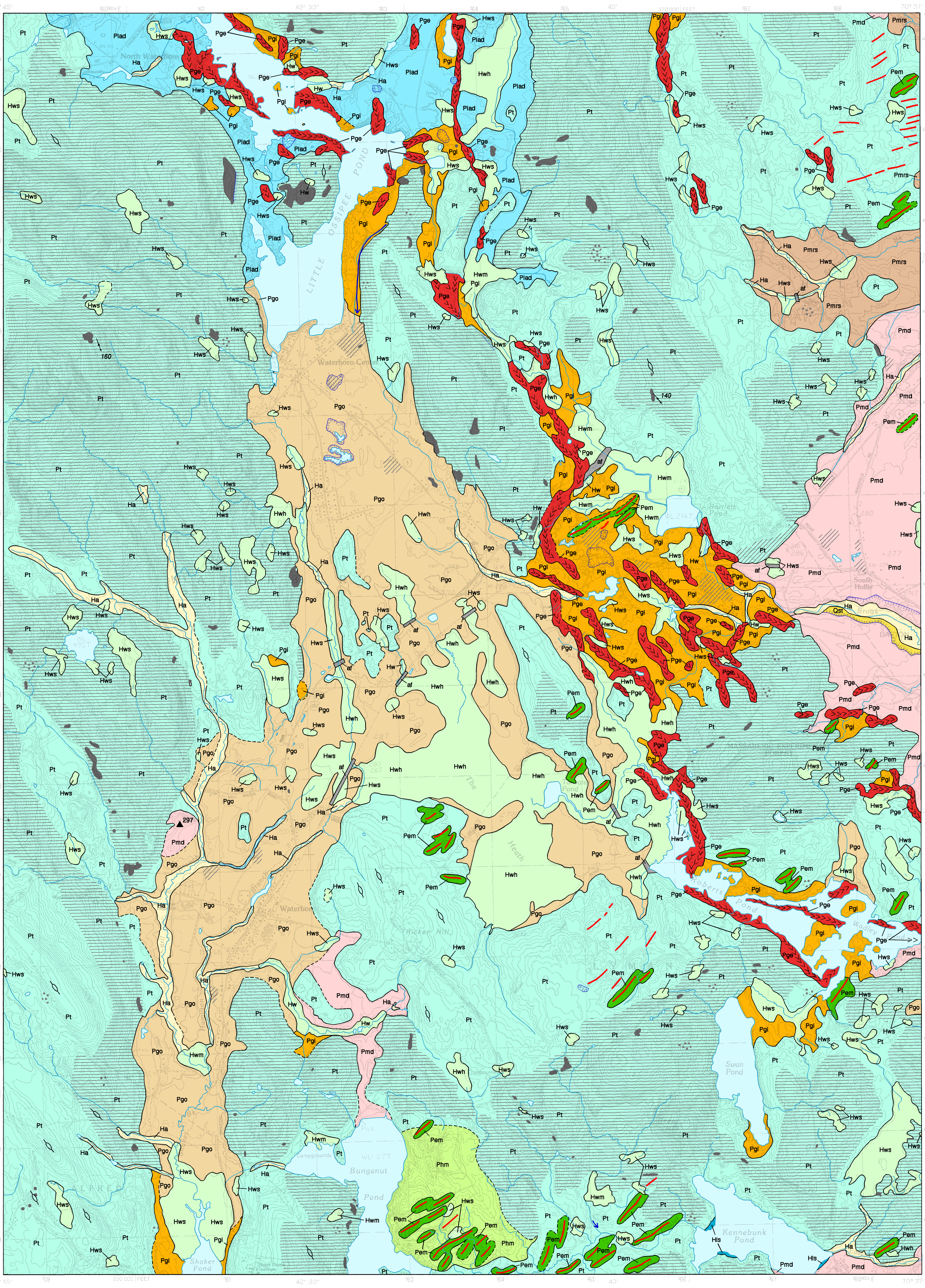
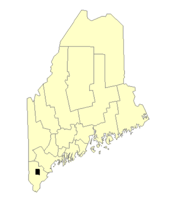
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping by Andres Meglioli completed during the 1990 field season; funding for this work provided by the U. S. Geological Survey COGEOMAP program. 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 10 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Waterboro 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.

HOLOCENE DEPOSITS

af — **Artificial fill** - Mainly composed of coarse gravel and sand, or various man-made materials.

Hls — **Lake shoreline** - Holocene shoreline of ponds and lakes. Deposits are comprised of fine to medium sand and subordinate pebbles. Mapped around Kennebunk Pond.

Ha — **Alluvium** - Generally well-sorted and stratified silt, sand, and gravel, deposited by modern streams. Associated with several brooks in the quadrangle.

Qst — **Postglacial stream terrace** - Largely composed of fine gravel and sand, on erosional surfaces with flat topography. A late Pleistocene or Holocene terrace is found along Cooks Brook, south of South Hollis.

Hws — **Wetland, swamp** - Wetland area, usually with abundant tree cover, but locally with open spaces. Fine-grained sediments (silt and clay) usually the underlying material. Little or no peat present. A well developed swamp is found on the north side of Shaker Pond, south of Waterboro.

Hwm — **Wetland, marsh** - Grasses and sedges are the dominant vegetation found here. A complete transition exists in the study area between the different types of wetlands. Like other wetlands, marshes develop on flat, poorly drained areas.

Hwh — **Wetland, heath** - Mosses, grasses and sedges are the dominant vegetation found here. Peat thickness varies considerably. Standing water is common.

Hw — **Wetland, undifferentiated** - Undifferentiated wetland, underlain by peat, muck, silt, or clay.

PLEISTOCENE DEPOSITS

Plad — **Lacustrine delta** - Chiefly composed of sand and fine gravel deposits with flat upper surfaces. The Lake Arrowhead glaciolacustrine delta deposits are found around Little Ossipee Pond.

Pmrs — **Marine regressive sand deposits** - Sand, silt, and minor clay deposited in the sea adjacent to glaciomarine delta deposits in the eastern part of the quadrangle.

Pmd — **Glaciomarine delta** - Deposits with flat upper surfaces and largely composed of sand and gravel. The South Hollis delta (located on the east boundary of the quadrangle) is the best developed of these deposits.

Pge — **Esker** - Generally discontinuous ridges, often sinuous, composed largely of stratified and interbedded sand and gravel, with pockets of well-rounded boulders and cobbles. These glaciofluvial deposits were formed in subglacial meltwater conduits during glacier retreat.

Pgi — **Ice-contact deposits** - Massive to variably interbedded sand and gravel deposited against or very close to the glacier, commonly with collapse features and irregular topography. In the Waterboro area, unit Pgi is usually associated with eskers.

Pgo — **Outwash** - Gravel and coarse sand deposits with a flat topographic surface (outwash plain). The outwash plain south of Little Ossipee Pond has been modified by postglacial stream erosion.

Pem — **End moraine** - Moraine ridge composed of till (silty-sandy diamicton) deposited at the margin of the last retreating glacier. Indicates the position of the ice margin during deposition. Several short ridges were found in the Waterboro quadrangle.

Phm — **Hummocky moraine** - Till deposits characterized by hummocky and very irregular topography, often with big angular boulders and numerous depressions. Till thickness varies greatly.

Pt — **Till** - Massive, poorly sorted diamicton with varying degrees of compaction. Deposited directly from glacial ice. Grain size ranges from clay to boulders. The unit is widely distributed throughout the quadrangle with thicknesses of 10 to 30 feet.

Bedrock - Gray areas indicate barren ledge. Horizontal ruled pattern indicates areas where surficial sediments are generally less than 10 feet thick. Gray dots show location of small outcrops, although some are exaggerated in size. Many bedrock exposures were too small to map precisely.

Area where the original topography has been modified or obliterated by excavation. Includes some gravel pits.

Contact - Indicates boundary between adjacent map units. Dashed where location is uncertain.

Glacially streamlined hill - Symbol indicates hills and bedrock knobs that have been elongated parallel to the flow of glacial ice.

135 **Glacial striation locality** - Dot marks points of observation; arrow shows ice movement direction inferred from striations on bedrock surface, with azimuth in degrees.

Terrace scarp - Adjacent to glacial meltwater channels and postglacial stream terraces.

>>>>> **Esker ridge** - Shows trend of sand and gravel ridge deposited in a meltwater channel within or beneath glacial ice. Chevrons point in the direction of former meltwater flow.

Kettle - Depression created by melting of buried glacial ice and collapse of overlying sediments.

Meltwater channel - Channel eroded by a glacial meltwater stream. Arrow shows known or inferred direction of flow.

▲350 **Glaciomarine delta** - Number indicates surveyed elevation in feet of the contact between topset and foreset beds, which marks the position of the corresponding sea level at the time of deposition.

End moraine ridge - Line indicates axis of till ridge deposited in the marginal zone of the receding ice sheet.

Boulder fields - Areas of numerous large boulders.

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. Meglioli, A., 1999, Surficial geology of the Waterboro 7.5-minute quadrangle, York County, Maine: Maine Geological Survey, Open-File Report 99-134, 7 p.
2. Meglioli, A., 1998, Surficial materials of the Waterboro quadrangle, Maine: Maine Geological Survey, Open-File Map 98-178.
3. Neil, C. D., 1998, Significant sand and gravel aquifers of the Waterboro quadrangle, Maine: Maine Geological Survey, Open-File Map 98-144.
4. Thompson, W. B., 1979, Surficial geology handbook for coastal Maine: Maine Geological Survey, 68 p. (out of print)
5. Thompson, W. B., and Borns, H. W., Jr., 1985, Surficial geologic map of Maine: Maine Geological Survey, scale 1:500,000.

Waterboro Quadrangle, Maine

Surficial geologic mapping by
Andres Meglioli

Digital cartography by:
Robert A. Johnston

Robert G. Marvinney
State Geologist

Cartographic design and editing by:
Robert D. Tucker

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DEPARTMENT OF CONSERVATION MAINE

Maine Geological Survey

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

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For additional information, see Open-File Report 99-134.

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 Waterboro 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.