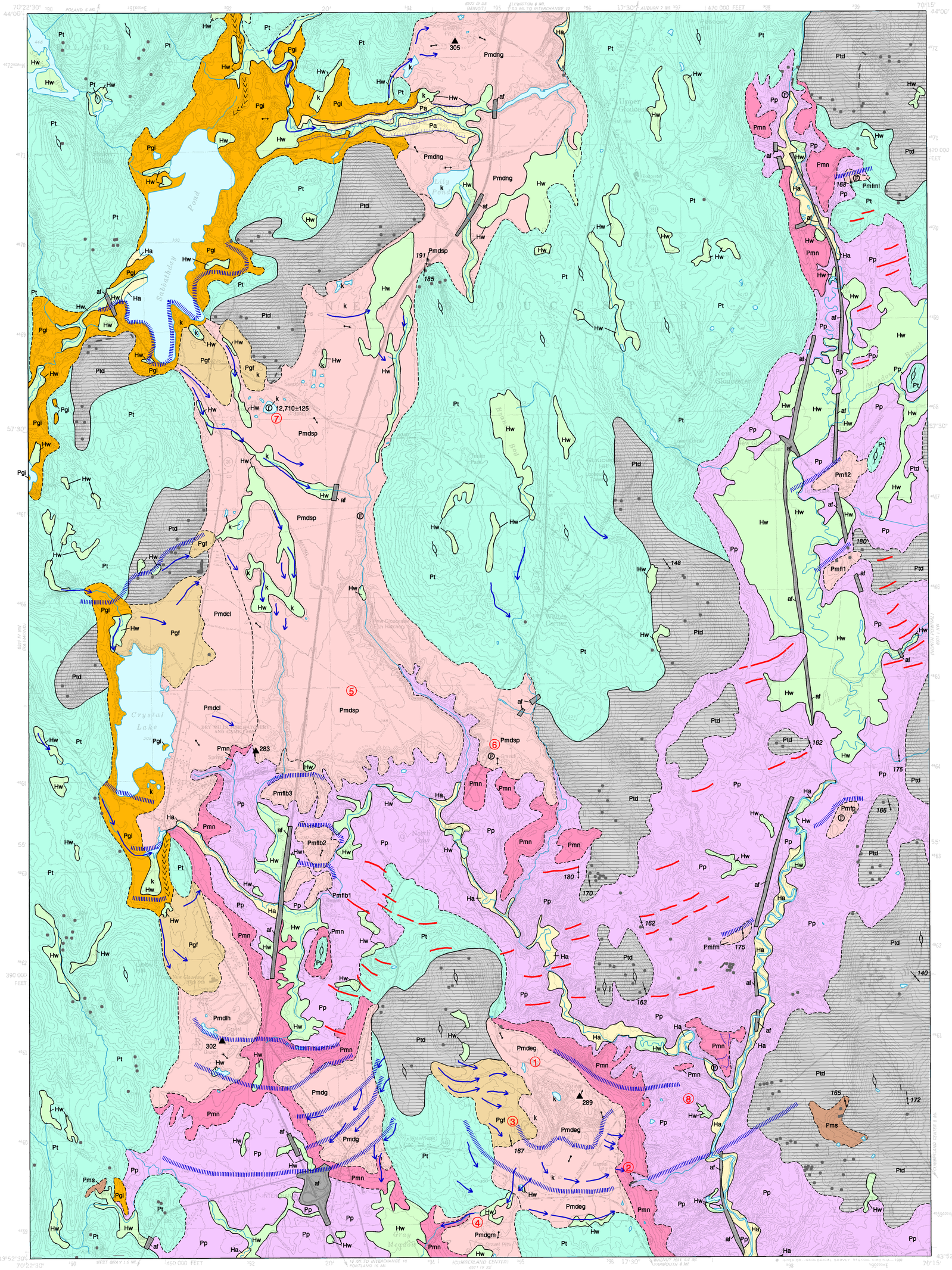
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping by Thomas K. Weddle completed during the 1995-1996 field seasons; funding for this work provided by the U.S. Geological Survey STATEMAP program.

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 Gray 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** - Includes landfills, highway and railroad embankments, and dredge spoil areas. These units are mapped only where they are resolvable using the contour lines on the map, or where they define the limits of wetland units. Minor artificial fill is present in virtually all developed areas of the quadrangle.

HOLOCENE DEPOSITS

Ha **Stream alluvium** - Gray to brown fine sand and silt with some gravel. Comprises flood plains along present streams and rivers. Extent of alluvium approximates areas of potential flooding.

Hw **Freshwater wetlands** - Muck, peat, silt, and sand. Poorly drained areas, often with standing water.

PLEISTOCENE DEPOSITS

Pa **Braided-stream alluvium** - Pleistocene alluvium consisting of fluvially deposited sand and gravel formed during the marine regression.

Pms **Marine shoreline** - Pleistocene beach and dune sands deposited during the regressive phase of marine submergence. Beach morphology is poorly preserved, but sand and gravel are present along the ridge crest.

Pmn **Marine nearshore deposits** - Pleistocene gravel, sand, and mud deposited as a result of wave activity in nearshore or shallow-marine environments; not associated with beach morphology.

Pp **Presumpscot Formation** - Massive to laminated silty clays with rare dropstones and occasional shelly horizons, which overlie rock and till, and are interbedded with and overlie end moraines and marine fan deposits; includes sand deposited as a distal unit of submarine fans.

Pmd **Marine ice-contact delta** - Glacial-marine delta composed primarily of sorted and stratified sand and gravel. Deposit was graded to surface of late-glacial sea and is distinguished by flat top and foreset and topset beds. Deltas have been assigned a unique geographic name listed below:

- Pmdng - New Gloucester delta
- Pmdsp - Sabbathday Pond delta
- Pmdcl - Crystal Lake delta
- Pmdlh - Libby Hill delta
- Pmdg - Gray delta
- Pmdeg - East Gray delta
- Pmdgm - Gray Meadow delta

Pmf **Submarine outwash fans** - Fan-shaped glacial-marine sand and gravel accumulations formed at the mouth of subglacial tunnels along the receding late Pleistocene ice margin. The sand and gravel is interbedded with and overlain by Presumpscot Formation clays at the distal edges of the fans, and interlayered with and overlain by tills at their ice-contact faces. Some fans, or group of fans have been assigned a unique geographic name listed below:

- Pmfm - Morse Road fan
- Pmfp - Penny Road fan
- $Pmflb_X$ - Libby Brook fans 1 to 3
- $Pmfi_X$ - Intervale fans 1 to 2
- Pmfml - Meadow Lane fan

Pgf **Glacial outwash fans and plains** - sand and gravel deposits comprised of alluvial fans and fan-shaped plains with large boulder and cobble clasts near er the fan apex.

Pgi **Ice-contact deposits** - Sand and gravel deposited against remnant masses of glacial ice; massive to well stratified; commonly has collapse features and irregular topography.

Pt **Till** - Gravelly to bouldery, sandy-matrix diamicton.

Ptd **Thin-drift areas** - Areas with generally less than ten feet of drift covering bedrock. Till overlies bedrock on hillslopes and ridge crests; Presumpscot Formation silty clay is present in depressions; and nearshore deposits overlie till, Presumpscot Formation, and bedrock on hillslopes and at the base of these slopes. Small rock outcrops, and areas of numerous small outcrops are shown as solid gray areas.

Contact - Indicates boundary between adjacent map units, dashed where approximate.

135 **Glacial striation or groove** - Arrow shows direction of former ice movement. Dot marks point of observation.

Streamlined hill - Hill shaped by glacial processes and reflecting regional ice flow.

End moraine - Ridge of till, sand, and gravel deposited and/or deformed by glacial ice.

Ice margin position - Line shows approximate position of ice margin during glacial retreat (shown only for major positions). Letters refer to map unit deposited when ice margin stood at each position.

Stream terrace scarp - Scarp separating different levels of stream terraces. Hachures on downslope side.

10,150±450 Ⓟ **Marine fossil locality** - Indicates site where marine fossils were located. Sites where valid radiocarbon ages were obtained also are shown.

10,150±450 Ⓕ **Non-marine fossil locality** - Indicates site where non-marine fossils were located. Sites where valid radiocarbon ages were obtained also are shown.

▲350 **Glaciomarine delta** - Elevation (in feet) of contact between topset and foreset beds in glaciomarine delta, which indicates former position of sea level.

Paleocurrent trend - Direction of current flow, inferred from dip of foreset bedor cross-bed trend.

<<<<< **Esker** - Gravel and sand deposited in an ice tunnel by subglacial meltwater stream. Chevrons point in direction of stream flow.

k **Kettle** - Depression on surface of stratified drift deposit where ice block buried by drift subsequently melted.

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

④ **Photo locality** - Location of photographed site shown and described in map legend.

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. Weddle, T. K., 1997, Surficial geology of the Gray 7.5-minute quadrangle, Androscoggin and Cumberland Counties, Maine: Maine Geological Survey, Open-File Report 97-73, 10 p.
2. Weddle, T. K., 1999, Surficial materials of the Gray quadrangle, Maine: Maine Geological Survey, Open-File Map 99-61.
3. Neil, C. D., 1999, Significant sand and gravel aquifers of the Gray quadrangle, Maine: Maine Geological Survey, Open-File Map 99-24.
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.

Gray Quadrangle, Maine

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1997

For additional information, see Open-File Report 97-73.

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, eroding and transporting boulders and other rock debris for miles. 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 Gray 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. 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 and submarine fans where streams discharged along the ice front, while the finer silt and clay dispersed across the ocean floor (**Localities 1-8**). 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. 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.

The last remnants of glacial ice probably were gone from Maine by 10,000 years ago. As the glacier left the region, the land emerged from the sea as a result of glacial unloading, a response of the earth's crust to the weight of the ice. Nearshore reworked deposits are the result of the land surface passing through the shore zone. 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. 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, 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.

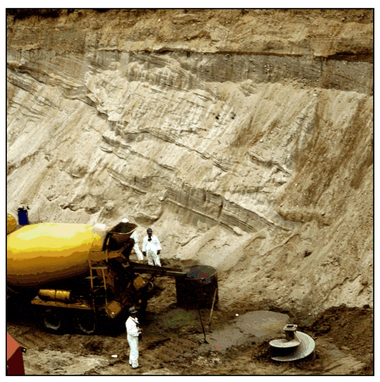
Dorion, C. C., 1993, A chronology of deglaciation and accompanying marine transgression in Maine: Geological Society of America, Abstracts with Programs, v. 25, no. 2, p. 12.

Leavitt, H. W., and Perkins, E. H., 1935, A survey of road materials and glacial geology of Maine; Volume II: glacial geology of Maine: Maine Technology Experiment Station, Bulletin 30, v. 2, 232 p.

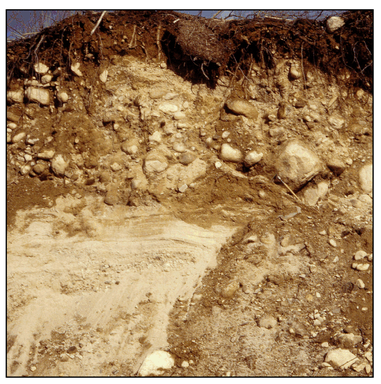
Sirkin, L., 1986, Pleistocene stratigraphy of Long Island, New York, *in* Caldwell, D. W. (editor), The Wisconsinan stage of the first geological district, eastern New York: New York State Museum, Bull. 455, p. 6-21.

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.

Locality 1. Overview of large gravel pit in East Gray delta (view to southeast). This ice-contact delta is the site of the largest kettle reported in Maine (Leavitt and Perkins, 1935). The topographic expression of the kettle is still visible on the quadrangle (marked by the letter k on the geologic map), however much of it has been obliterated by mining.



Locality 2. At the East Gray delta, cleanup of the McKin Superfund site is underway (note large auger in floor of excavation). Air stripping of contaminated ground water has occurred since the mid-1980's, however the contamination plume is still present and discharges from springs along the delta front to the east. The topset/foreset contact of the delta is visible near the top of the exposure. *(photo by Rebecca Hewett).*



Locality 3. Alluvial fan deposits overlying deltaic deposits. Coarse-grained sediment from a glacial source in the highland between Gray and east Gray prograded as a glacial alluvial fan (unit Pgf on the geologic map) over the deltaic sediments of the East Gray delta (unit Pmdeg on the geologic map). Strongly incised meltwater channels in the topography are present on the surface of the fan and delta.

Locality 4. The Gray Meadow delta (unit Pmdgm on the geologic map) probably formed slightly earlier than the East Gray delta. Later, meltwater from the alluvial fan of Figure 3 reworked sediment on the surface of the Gray Meadow delta. Locally ponded deposits in the center of the photo are deformed by dewatering and loading due to the deposition of the overlying coarse-grained outwash.

Locality 5. The flat surface of the Sabbathday Pond delta (unit Pmdsp on the geologic map) is characteristic of glaciomarine deltas. In Maine, delta tops are commonly used for agricultural practices, such as blueberry or potato cultivation. This delta is noteworthy because of its size, a result of the ice-margin remaining in the Sabbathday Pond drainage basin during the early stage of glacial unloading and emergence from the sea.

Locality 6. Distal beds of the Sabbathday Pond delta. The interbedded fine-grained deposits have burrows in the sediment most likely from molluscs. The dark and light bands represent cyclical deposition, possibly daily tidal cycles. The grouping of thinner beds in the center may be part of the diurnal cycle.

Locality 7. During deglaciation, a remnant block of glacial ice was buried by stream deposits beneath the surface of the Sabbathday Pond delta. The block eventually melted, producing a depression called a kettle, now filled with water and named The Sinkhole. Davis and Jacobson (1985) dated a sediment core from this pond and reported a radiocarbon age of 12,710+/-125 yr B.P., a minimum age for the delta.

Locality 8. Typical topography associated with the glaciomarine mud called the Presumpscot Formation (unit Pp on the geologic map). This fine-grained glacial sediment was deposited in the sea during deglaciation. The mud commonly erodes in hummocky, steep-gullied surfaces, well represented by the topography of the Royal River valley in the southeastern part of the quadrangle.