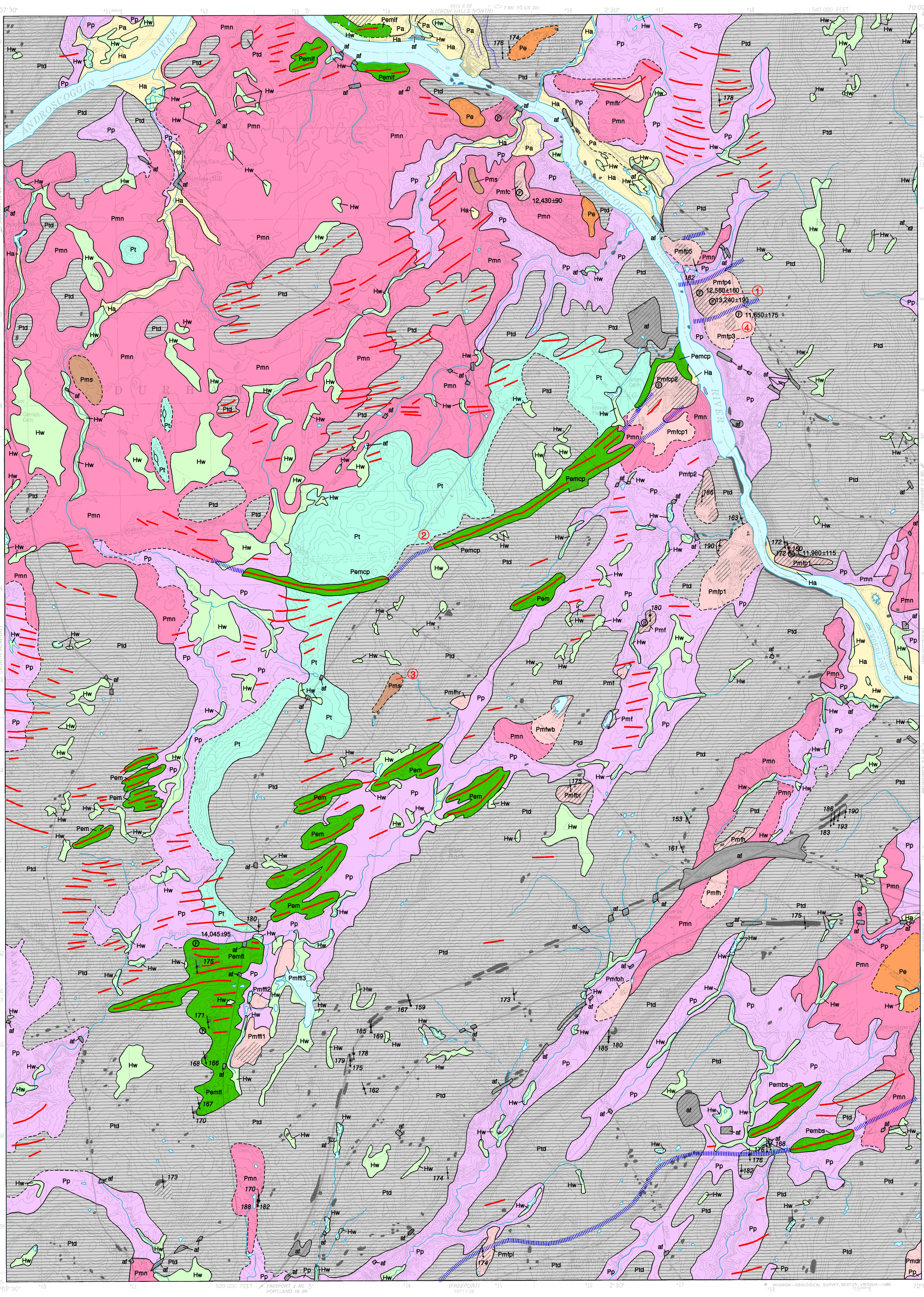
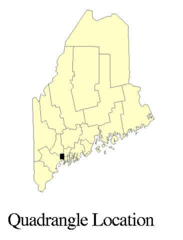
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping by Thomas K. Weddle completed during the 1993-1994 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 Lisbon Falls South 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.
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.
Pe	**Eolian deposits** - Pleistocene eolian deposits comprised of mantle of wind-blown sand and dunes formed following the marine regression.
Pa	**Braided-stream alluvium** - Pleistocene alluvium consisting of fluvially deposited sand and gravel; trough-crossbeds with rare mud drapes and intraclasts are representative of braided streams and coastal braid-delta environment formed during the marine regression.
Pmdr	**Regressive marine delta**
Pms	**Marine shoreline** - Pleistocene beach and dune sands deposited during 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.
Pem	**End moraines** - Linear ridges consisting of bedded sand and gravel interbedded with Presumpscot Formation silty clays and overlain by till on the ice-proximal faces of the moraines. Some moraines, or groups of moraines, have been assigned a unique geographic name listed below:

Pemlf - Lisbon Falls moraines
Pemcp - Cox Pinnacle moraines
Pemfl - Florida Lake moraines
Pembs - Bunganuc Stream moraines

Pmf	**Submarine outwash fans** - Thick 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:

Pmflr - Little River fan
Pmfc - Crossman Corner fan
$Pmfcp_X$ - Cox Pinnacle fan 1 to 2
$Pmfp_X$ - Pejepscot fan 1 to 5
Pmfhr - Hacker Road fan
Pmfwb - Whites Beach fan
Pmfbr - Bald Rock fan
Pmfh - Hillside fan
Pmfoh - Oak Hill fan
$Pmffl_X$ - Florida Lake fan 1 to 3
Pmfpl - Pleasant Hill fan

The correlations of these marine fan deposits and the end moraines are shown in Weddle (1997).

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 clays are 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 between units; dashed where inferred

135 Striations - observations made at dot. Number indicates azimuth (in degrees) of ice-flow direction. Where two directions are observed in the same outcrop, flags indicate older trends where discerned.

End moraine crests.

Scarps.

Mapped and inferred ice marginal positions.

Areas where original topography is disturbed by excavation (chiefly gravel pits).

10,150±450 Marine fossil locality.

Drumlin.

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 Lisbon Falls South 7.5-minute quadrangle, Androscoggin, Cumberland, and Sagadahoc Counties, Maine: Maine Geological Survey, Open-File Report 97-64, 12 p.
2. Weddle, T. K., 1999, Surficial materials of the Lisbon Falls South quadrangle, Maine: Maine Geological Survey, Open-File Map 99-63.
3. Neil, C. D., 1999, Significant sand and gravel aquifers of the Lisbon Falls South quadrangle, Maine: Maine Geological Survey, Open-File Map 99-26.
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.
6. 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.

Lisbon Falls South Quadrangle, Maine

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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 Lisbon Falls South 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 (**Figures 1-3**). 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. The shells of clams, mussels, and other invertebrates are found in the glacial-marine clay that blankets lowland areas of southern Maine (**Figure 4**). 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 (**Figure 5**). 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 (**Figure 6**). 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 (**Figures 7, 8**). 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

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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.

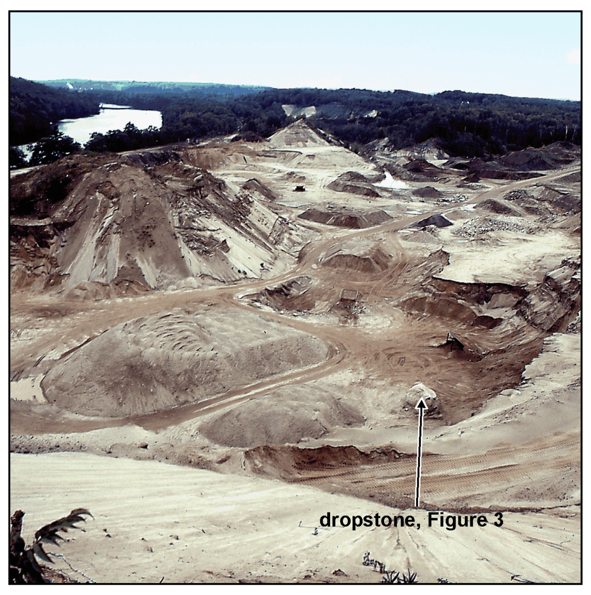

Figure 1. At **Locality 1**, several glaciomarine fans (Pmfp) were deposited when the glacier margin was at the site. Fossil shells found in similar deposits (Pemlf) to the south provided radiocarbon ages of about 14,000 yr B.P., inferring the time when the glacier retreated from the region. The photo shows the working gravel pits and extent of the glaciomarine fans. View to north with Androscoggin River in background.

Figure 2. The sediments in this photo from **Locality 1** are located in the middle of the glaciomarine fan. The layering is characteristic of high-energy discharge of sediment, which avalanched rapidly down the slope of the fan in a sheet-like flow. The dune-shaped features in the center of the exposure may be sedimentary structures known as antidunes, which form under high-energy depositional conditions. Flow direction is from right to left in photo.

Figure 3. The large boulder in this photo is a dropstone found in the finer grained sediment of the middle part of the fan in **Locality 1**. The boulder probably was deposited from a melting iceberg floating in the sea, which at this time was as high as 300 feet elevation. The shoreline deposit shown in Figure 7 provides an estimate of sea level at this time, which was about 100 feet over the top of the fan in which the boulder was found.

Figure 4. Shells (about 1.5 inches long) of the mollusc *Hiatella arctica* from **Locality 1**. The molluscs are found in glaciomarine mud, which was deposited when the sea covered the region during deglaciation. Other molluscs found at an elevation of 190 feet at this locality had a radiocarbon age estimated at 13,240 +/- 190 yr B.P. This age provides an estimate for when sea level was close to that elevation.

Figure 5. Meltwater streams flowing in tunnels in the glacier transported sediment to the ocean. These tunnels often became choked with sediment, and after the ice melted, the resulting deposit formed an esker. In the glaciomarine environment, the coarse-grained esker may become buried by younger glaciomarine fan deposits, as is shown in the photo above (*photo by Ilya Buynevich*).

Figure 6. The Cox Pinnacle moraine (Pemcp) is unusual for southwestern Maine by virtue of its length, size, and continuity. It traces the position of the ice margin over Cox Pinnacle where it was pinned to the highland. In places, large boulders protrude from its crest (shown in photo, **Locality 2**).

Figure 7. Locality 3 is the site of a marine shoreline feature (Pms), a beach, represented by a break in slope on a sandy deposit found at about 300 ft elevation ¾ mile southwest of Cox Pinnacle at Lunt Memorial Cemetery. The beach approximates the highstand of the glacial sea in the region.

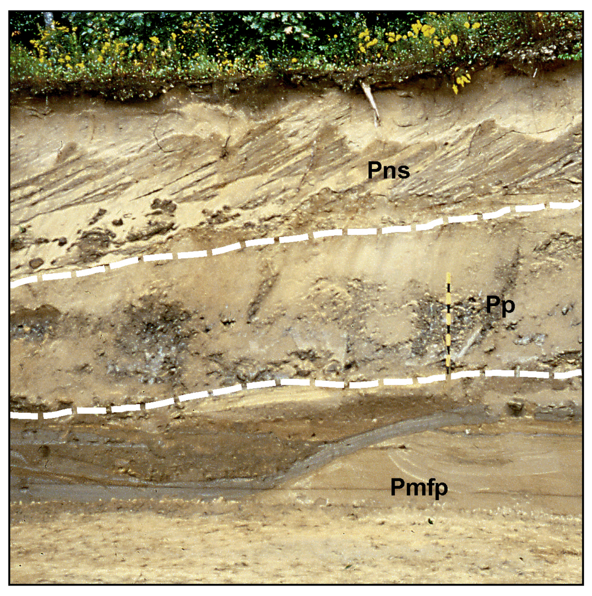

Figure 8. Cross-bedding in a nearshore deposit (Pns), possibly a spit, which overlies glaciomarine mud (Pp). The mud was deposited in the sea after the glacier receded. Below the mud is layered sand and mud, part of the glaciomarine fan (Pmfp) at **Locality 2**. This deposit is at a lower elevation than the beach in Figure 7. It shows the effect of waves on the landscape as it emerged from the glacial sea (**Locality 4**; *photo by Joseph Kelley*).