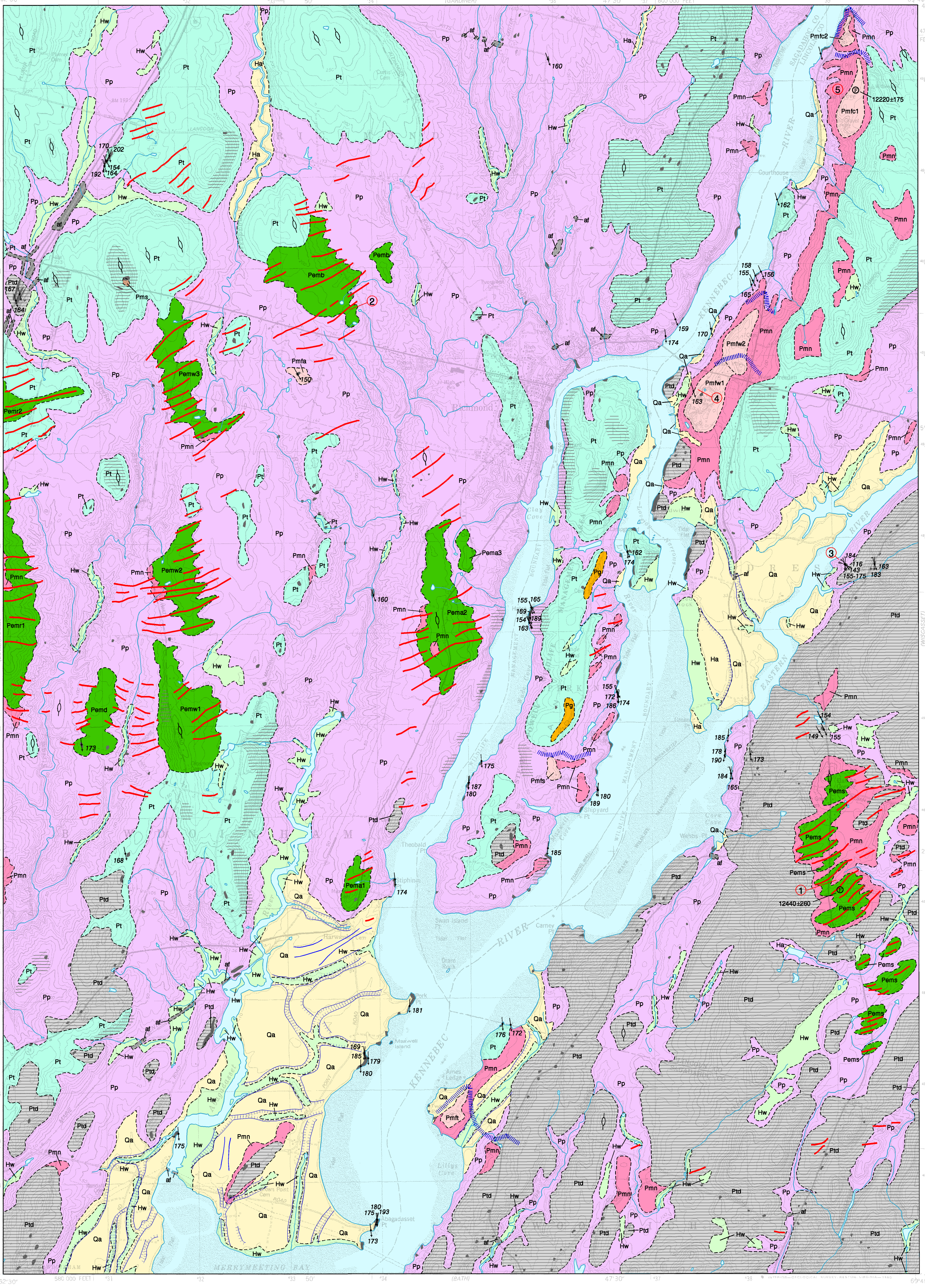
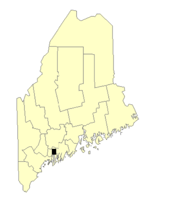
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping of the Richmond quadrangle was conducted by Thomas K. Weddle and Daniel S. Frost during the 2003 field season. Funding for this work was provided by the U. S. Geological Survey STATEMAP program, the Association of American State Geologists Field Research Experiences for Undergraduates Mentoring 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 Richmond 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.

NOTE: A thin, discontinuous layer of windblown sand and silt, generally mixed with underlying glacial deposits by frost action and bioturbation, is present near the ground surface over much of the map area but is not shown.

af — **Artificial fill** - Man-made. Material varies from natural sand and gravel to quarry waste to sanitary landfill, including highway and railroad embankments and dredge spoil areas. 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.

Ha / Qa — **Stream alluvium** (Ha - Holocene, Qa - Quaternary) - Sand, silt, gravel, and muck in flood plains along present rivers and streams. Extent of alluvium indicates most areas flooded in the past that may be subject to future flooding. In places, this unit is indistinguishable from, grades into, or is interbedded with wetlands deposits (Hw).

Hw — **Wetland deposit** (Holocene) - Muck, peat, silt, and sand deposited in poorly drained areas. In places, this unit is indistinguishable from, grades into, or is interbedded with stream alluvium (Ha).

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) - Sand, silt, mud, and minor gravel. Consists of reworked ice-contact, till, submarine outwash, and bottom materials redistributed by marine currents and wave action as sea level fell during late-glacial time. May contain shoreline, beach, and dune deposits in places.

Pg — **Undifferentiated ice-contact deposits** (Pleistocene) - Sand, gravel, and silt ice-contact deposits. May include esker or glaciomarine fan deposits.

Pp — **Presumpscot Formation: Glaciomarine bottom deposits** (Pleistocene) - Silt and clay with local sandy beds and intercalations. Consists of late-glacial fine-grained (marine mud) bottom deposits. Commonly lies beneath surface deposits of unit Pmn; in places, may be coated with unmapped thin dune deposits.

Pem — **End moraines** - Linear ridges consisting of bedded sand and gravel interbedded with Presumpscot Formation silty clay and occasionally interlayered with till on the ice-proximal faces of the moraines. Some moraines, or groups of moraines, have been assigned a unique geographic name listed below:

- Pemb - Baker Brook moraines
- $Pemr_x$ - Ridge Road moraines 1-2
- Pemd - Denham Stream moraines
- $Pemw_x$ - White Road moraines 1-3
- $Pema_x$ - Abagadasset River moraines 1-3
- Pems - South Dresden 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 occasionally interlayered with till at their ice-contact faces. Some fans, or group of fans have been assigned a unique geographic name listed below:

- $Pmfc_x$ - Cedar Grove fans 1-2
- $Pmfw_x$ - West Dresden fans 1-2
- Pmfa - Abagadasset River fan
- Pmfs - Swan Island fan
- Pmft - Twing Point fan

Pt — **Till** (Pleistocene) - Light- to dark-gray, nonsorted to poorly sorted mixture of clay, silt, sand, pebbles, cobbles, and boulders; a predominantly sandy diamicton containing some gravel. Generally underlies most other deposits. Many streamlined hills in this area are bedrock-cored.

Ptd — **Thin glacial drift** (Pleistocene) - Areas with generally less than 10 ft 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.

Bedrock exposures - Not all individual outcrops are shown on the map. Gray dots indicate individual outcrops; ruled pattern indicates areas of abundant exposures and areas where surficial deposits are generally less than 10 ft thick. Mapped in part from aerial photography, soil surveys (McEwen, 1970; Hedstrom, 1987), and previous geologic (Thompson and Smith, 1977; Thompson and Borns, 1985) and materials maps (Locke, 1999).

Contact - Boundary between units, approximately located.

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.

Drumlin form or streamlined hill. Indicates general direction of glacial ice movement.

Moraine ridge - Ridge of till, sand, and gravel deposited and/or deformed by glacial ice, often mantled by Presumpscot Formation.

Stream channels and scarps.

Meander scars.

Mapped and inferred **ice marginal positions**.

10,150±450 (F) — **Marine fossil locality**. 600 years subtracted from lab analysis for marine reservoir correction (Weddle and Retelle, M. J., 2001).

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

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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

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3. Thompson, W. B., 1979, Surficial geology handbook for coastal Maine: Maine Geological Survey, 68 p. (out of print).

Richmond Quadrangle, Maine

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2009
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SURFICIAL GEOLOGY OF MAINE

Continental glaciers as large as 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. The map at left shows the pattern of glacial sediments in the Richmond quadrangle.

The most recent "Ice Age" in Maine began about 25,000 years ago, when an ice sheet spread southward over New England. 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 creating grooves and fine scratches (striations). Erosion and sediment deposition by the ice sheet streamlined many hills, with their long dimension parallel to the direction of ice flow.

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. The edge of the glacier reached the present position of the Maine coast by 13,800 years ago. 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 465 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. 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.

The last remnants of glacial ice probably were gone from Maine by 10,000 years ago. 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. Geologic processes are by no means dormant today, however, as rivers continue to modify the land surface.

Photo 1 (Locality 1). Moraine along Route 127, South Dresden. Lone white pine in center of image is on the crest of the moraine, which also is mirrored by white fence on left of photo. To the right in photo is the flank of another moraine, parallel with the trend of the one on the left, southwest to northeast. A moraine is a landform that marks the location of the ice margin during glacial retreat, and is formed either as an ice-shove feature by a minor readvance of the ice, or is an ice-marginal deposit of sand and gravel laid down on the sea floor by fluvial systems emanating from beneath the ice into the sea at the ice margin, and often termed moraine banks.

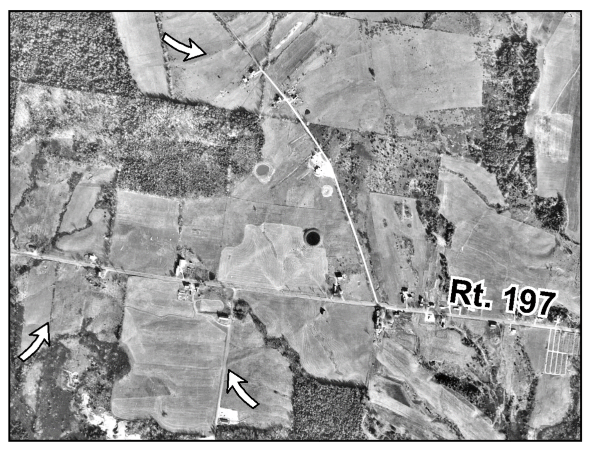

Photo 2 (Locality 2). Air photo of moraines in Richmond (arrows highlight moraines). East-west road in lower half of photo is Route 197. The regular spacing between consecutive moraine crests, here about 400 feet, suggests seasonal cyclicity representing retreat and minor readvance, possibly during summer and winter months, respectively. These moraines are commonly referred to as De Geer, washboard, or cross-valley moraines, and may be formed at the grounding line of the glacier, the line where the ice margin begins to float, losing contact with its bed. The grounding line can be some distance back from the true ice margin.

Photo 3 (Locality 3). Landscaped pond excavation, off Route 127 near Eastern River, Dresden. Excavation shows contact between glacial marine mud (Presumpscot Formation; upper left half of photo) overlying sandy diamicton (till; upper right of photo), overlying bedrock (lower center of photo) sculpted by subglacial meltwater (marker pen circled for scale). Subglacial meltwater channel in central area of outcrop is partly filled with till delineating the sinuous channel trend.

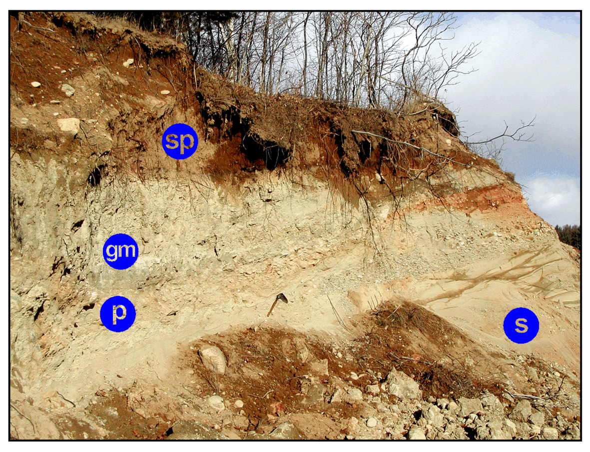

Photo 4 (Locality 4). Gravel pit in West Dresden glacial marine fan deposit, proximal to mid-fan environment, off Route 197, West Dresden. Deformed medium sand (s) overlain by pebble gravel (p) and blanketed by glacial marine mud (gm). Upper rusty-colored bouldery unit is emplaced spoil pile material (sp), not natural to the stratigraphy.

Photo 5 (Locality 4). Strongly striated and polished bedrock, striation azimuthal trend 163 degrees. Bedrock is mapped as Nehumkeag Pond Member of the Cushing Formation (Newberg, 1992), now regarded as Nehumkeag Pond Formation of the Falmouth-Brunswick Sequence (Hussey, 1989; Hussey and Berry, 1998; Hussey and Marvinney, 2002).

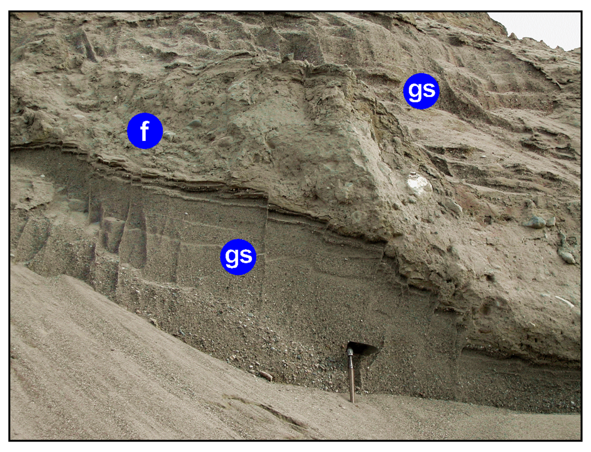

Photo 6 (Locality 5). Gravel pit in Cedar Grove glacial marine fan deposit, proximal to mid-fan environment, off Route 128, Dresden. Flowtill layer (f) between gravelly sand layers (gs). Flowtill is formed by slumping of diamicton from the ice surface or off of adjacent deposits. Here it was deposited on stratified drift and subsequently buried by more gravelly sand. Eventually, the combined stratified drift and flowtill slumped again, possibly by melting of buried ice or by syndepositional slumping and deformation. Vertical and near-vertical sand stringers, possible dewatering structures associated with deposition of the flowtill or slumping, are found along offsets in the underlying sand and at the base of the flowtill. These offsets do not propagate very far upward into the flowtill. Progressive downward displacement of sand layers and the base of the flowtill toward the right in the photo, as well as downwarping of the upper surface of the flowtill in that direction may be due to a melted ice block that was buried to the right.

Photo 7 (Locality 5). Mid-fan environment. Bedded gravelly sand and coarse to medium sand in fan foreset beds. Grossly, two cyclic events are represented by the upward coarse-to-fine sequence from the bottom of the section to the center of the image and another above the shovel. Multiple depositional events are represented within each gross sequence, but overall the section records a repetitive change from higher-energy to lower-energy depositional conditions.

Photo 8 (Locality 5). Mid-to-distal fan environment. Laterally continuous, horizontally bedded medium and fine sand layers and silt layers. The layers are very low-angle dipping foreset beds deposited near the toe of the fan. In this case, these beds are shingled over older mid-to-proximal coarse grained fan deposits, which are being actively mined in another part of the pit (see photos 6 and 7 above).

Photo 9 (Locality 5). Distal fan and nearshore environment. Reworked glacial marine fan sediment, fine-grained tan sand deposited by nearshore processes overlying gray glacial marine mud. Rilled and gullied surface on mud is characteristic of fresh mud exposure. The mud occurs stratigraphically above the horizontal beds shown in the previous photo.

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