Richmond Quadrangle, Maine

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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.

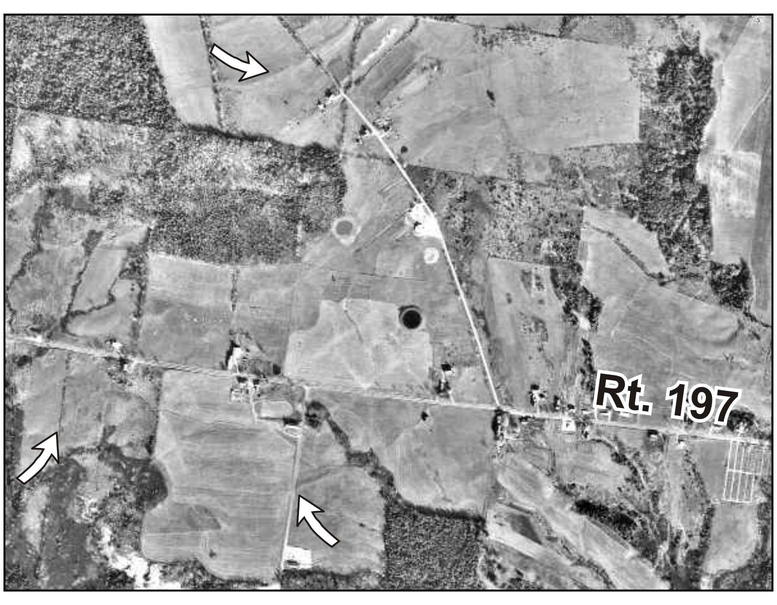

Photo 2 (Locality 2). Air photo of moraines in Richmond (arrows highlight moraines). East-west road in lower half of photo is Route 197. The regular spacing between consecutive moraine crests, here about 400 feet, suggests seasonal cyclicity representing retreat and minor readvance, possibly during summer 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.

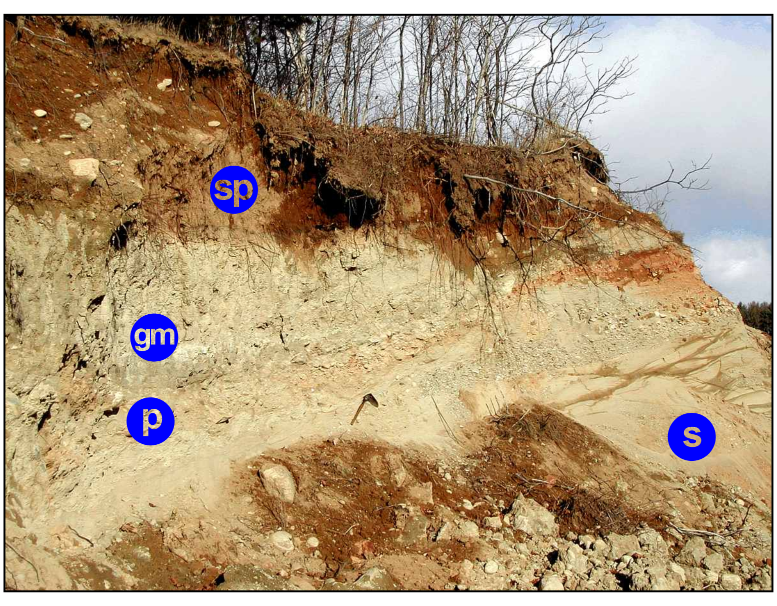

Photo 4 (Locality 4). Gravel pit in West Dresden glacial marine fan deposit, proximal to mid-fan environment, off Route 197, West Dresden. Deformed medium sand (s) overlain by pebble gravel (p) and blanketed by glacial marine mud (gm). Upper rusty-colored bouldery unit is emplaced spoil pile material (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).

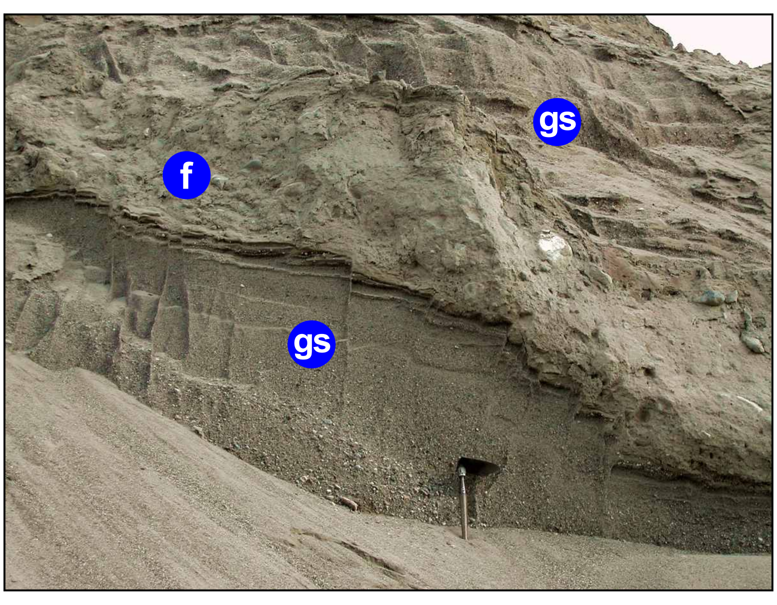

Photo 6 (Locality 5). Gravel pit in Cedar Grove glacial marine fan deposit, proximal to mid-fan environment, off Route 128, Dresden. Flowtill layer (f) between gravelly sand layers (gs). Flowtill is formed by slumping of diamicton from the ice surface or off of adjacent deposits. Here it was deposited 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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