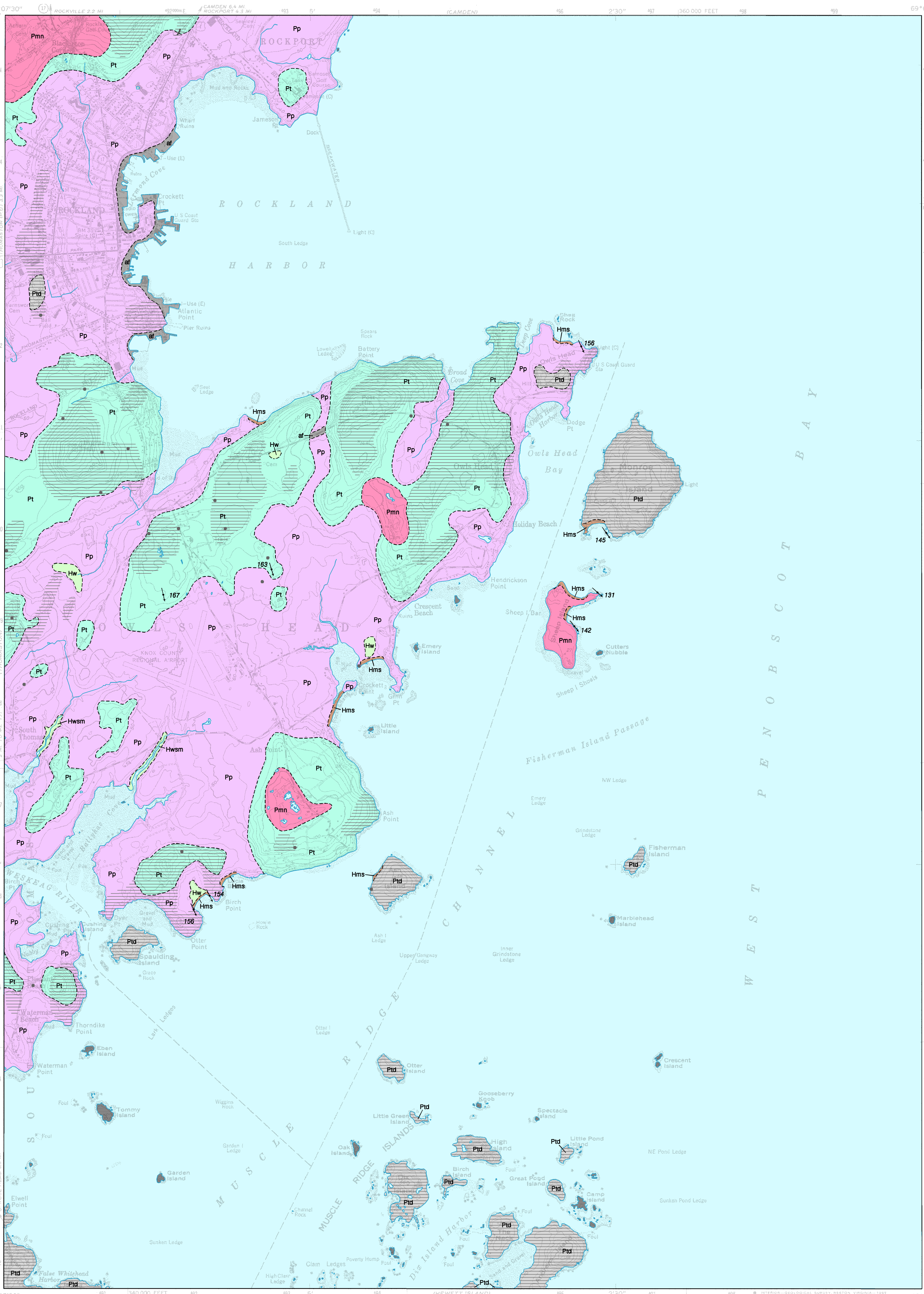
Surficial Geology



Rockland Quadrangle, Maine

Surficial geologic mapping by
Woodrow B. Thompson

Digital cartography by:
Robert A. Johnston

Robert G. Marvinney
State Geologist

Cartographic design and editing by:
Robert D. Tucker

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Maine Geological Survey

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

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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 Rockland quadrangle.

The most recent "Ice Age" in Maine began about 30,000 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 calendar years ago, soon after it reached its southernmost position on Long Island (Ridge, 2004). The edge of the glacier withdrew from the continental shelf east of Long Island and reached the present position of the Maine coast by about 16,000 years ago (Borns and others, 2004). 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. The shells of clams, mussels, and other invertebrates are found in the glacial-marine clay that blankets lowland areas of southern Maine. Ages of these fossils tell us that ocean waters covered parts of Maine until about 13,000 years ago. The land rebounded as the weight of the ice sheet was removed, forcing the sea to retreat.

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 12,000 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 . 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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Figure 1. Glacially abraded granite ledge on the shoreline at Birch Point State Park in Owls Head. This outcrop is located at the north end of the park beach. The grooves on the ledge indicate ice flow toward 154° (south-southeast). Photo by W. B. Thompson.

Figure 2. Glacial grooves trending 156° (parallel to red pencil) on granite outcrop at south end of beach, Birch Point State Park. Photo shows that grooves are more clearly visible on wet surfaces. Photo by W. B. Thompson.

Figure 3. A stony heterogeneous sediment called "till" was released from melting glacial ice in the Rockland quadrangle. Boulders scattered across the ground surface often indicate the presence of till, as seen in this road cut. Photo by W. B. Thompson.

Figure 4. Many low areas in the quadrangle are underlain by clay, silt, and fine sand deposited on the sea floor during the period of marine submergence that immediately followed glacial retreat. This muddy sediment is called the Presumpscot Formation, known locally as "blue clay" where unweathered. Natural fresh exposures of the clay are not readily seen in the map area (the one shown here is actually in nearby Waldoboro) and are most likely to be found along stream banks and the ocean shore. The embedded pebble in the upper part of the photo probably dropped to the ocean bottom from a floating iceberg. Photo by W. B. Thompson.

Figure 5. Aerial view of landslide that destroyed two houses on north shore of Rockland Harbor in April, 1996 (Berry and others, 1996; photo by PDQ Photography). This and other slides in the Rockland area have occurred in marine clay of the Presumpscot Formation. They resulted at least in part from oversteeping of bluffs due to shoreline erosion.

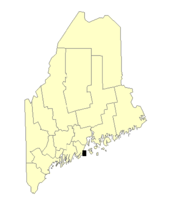
Figure 6. Headward part of the 1996 Rockland landslide, showing tilted trees on slumped blocks of marine clay. Photo by W. B. Thompson.

Figure 7. Marine shoreline bluff on east side of Sheep Island. The bluff exposes stratified gravel that formed as the island was washed by the ocean during regression of the sea from its late-glacial high stand. The gravel is mapped as unit Pmn (marine nearshore deposit). Maine Geological Survey photo by H. N. Berry IV.

Figure 8. Gravel ridge on upper edge of the beach at Birch Point State Park. A wetland has formed where fresh water is impounded behind the beach. See the following website for more information on the park's geology: http://www.maine.gov/doc/nrimc/mgs/explore/bedrock/sites/jun09-slides/jun09-slides.htm. Photo by W. B. Thompson.

SOURCES OF INFORMATION

Surficial geologic mapping of the Rockland quadrangle was conducted by Woodrow B. Thompson during the 2009 field season. Funding for this work was provided by the U. S. Geological Survey STATEMAP 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 Rockland 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.

Hms — **Marine shoreline deposits** - Sand and gravel on modern ocean beaches.

Hw — **Wetland deposits** - Peat, muck, silt, and clay in poorly drained areas.

Hwsm — **Salt marsh** - Salt-marsh peat, muck, and fine-grained sediments deposited in coastal tidewater environments.

Pmn — **Marine nearshore deposits** - Sandy to gravelly sediments formed in late-glacial time when marine processes reworked glacial deposits during regression of the sea.

Pp — **Presumpscot Formation** - Glaciomarine silt, clay, and sand deposited on the late-glacial sea floor. This map unit overlies the irregular surface of glacial till in a complex manner, so it is likely to include areas of till exposed at the ground surface.

Pt — **Till** - Loose to very compact, poorly sorted, massive to weakly stratified mixture of sand, silt, and gravel-size rock debris deposited by glacial ice. Boulders are commonly scattered across the ground surface. This map unit locally includes lenses of water-laid sand and gravel, as well as patches of overlying Presumpscot Formation (unit Pp).

Ptd — **Thin drift, undifferentiated** - Area of thin patchy sediment cover on bedrock, in which exposure is generally poor and the sediments may include till, Presumpscot Formation, and/or marine nearshore deposits. This unit occurs mainly in coastal areas and islands where bedrock outcrops are extensive.

Bedrock outcrops/thin-drift areas - Ruled pattern indicates areas where bedrock outcrops are common and/or surficial sediments are generally less than 10 ft thick. Mapped from air photos and ground observations. Actual thin-drift areas probably are more extensive than shown. Dots mark locations of individual outcrops.

af — **Artificial fill** - Variable mixtures of earth, rock, and/or man-made materials used as fill for docks, buildings, and parking lots on waterfront in Rockland harbor.

Contact - Boundary between map units. Many contacts are approximately located and therefore indicated by dashed lines.

135 — **Glacial striation locality** - Arrow shows ice-flow direction(s) inferred from striations on bedrock. Dot marks point of observation. Number is azimuth (in degrees) of flow direction.

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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