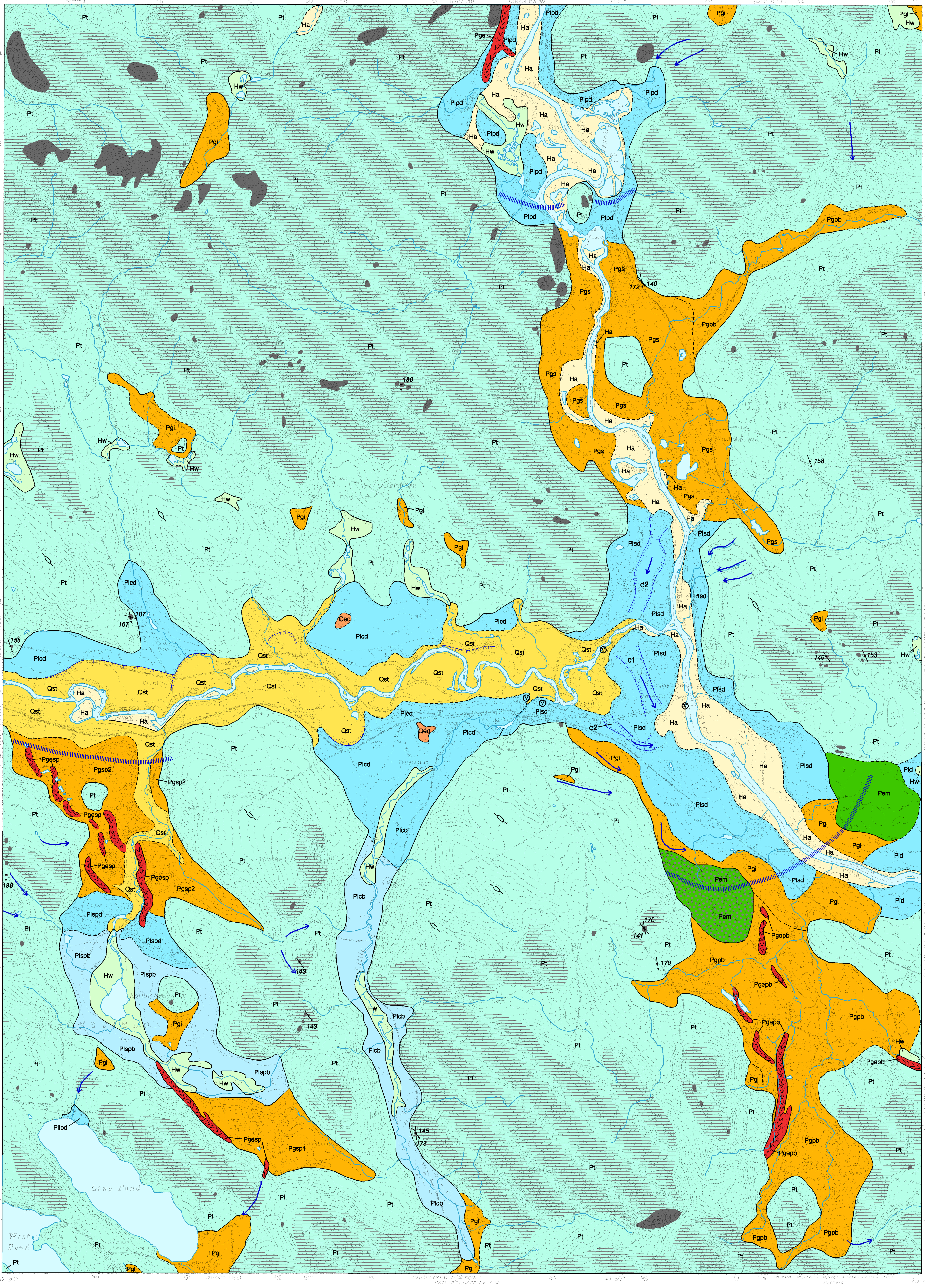
Surficial Geology



Cornish 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 (**Figure 1**), eroding and transporting boulders and other rock debris for miles (**Figure 2**). 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 Cornish 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 (**Figure 3**). 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 (**Figure 4**) 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. 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 (**Figure 5**). 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 (**Figure 6**).

The last remnants of glacial ice probably were gone from Maine by 10,000 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 (**Figure 7**). 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 (**Figure 8**), and worldwide sea level is gradually rising against Maine's coast.

References Cited

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Figure 1: "The Bubbles" and Jordan Pond in Acadia National Park. These hills and valleys were sculpted by glacial erosion. The pond was dammed behind a moraine ridge during retreat of the ice sheet.

Figure 2: Daggett's Rock in Phillips. This is the largest known glacially transported boulder in Maine. It is about 100 feet long and estimated to weigh 8,000 tons.

Figure 3: Granite ledge in Westbrook, showing polished and grooved surface resulting from glacial abrasion. The grooves and shape of the ledge indicate ice flow toward the southeast.

Figure 4: Glaciomarine delta in Franklin, formed by sand and gravel washing into the ocean from the glacier margin. The flat delta top marks approximate former sea level. Kettle hole in foreground was left by melting of ice.

Figure 5: Esker cutting across Kezar Five Ponds, Waterford. The ridge consists of sand and gravel deposited by meltwater flowing in a tunnel beneath glacial ice.

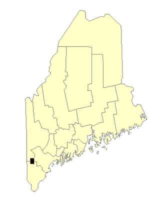
Figure 6: Aerial view of moraine ridges in blueberry field, Sedgwick (note dirt road in upper right for scale). Each bouldery ridge marks a position of the retreating glacier margin. The ice receded from right to left.

Figure 7: Sand dune in Wayne. This and other "deserts" in Maine formed as windstorms in late-glacial time blew sand out of valleys, often depositing it as dune fields on hillsides downwind. Some dunes were reactivated in historical time when grazing animals stripped the vegetation cover.

Figure 8 : Songo River delta and Songo Beach, Sebago Lake State Park, Naples. These deposits are typical of geological features formed in Maine since the Ice Age.

SOURCES OF INFORMATION

Surficial geologic mapping by Robert M. Newton completed during the 1992-1996 field seasons; funding for this work provided by the U. S. Geological Survey STATEMAP program. William R. Holland conducted additional surficial geologic and materials field work during the 1983 field season, funded by the significant sand and gravel aquifer program of the Maine Geological Survey.



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 20 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Cornish 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.

Symbol	Description
Ha	**Alluvium** - Fine to coarse sand, silt, and gravel deposited by modern streams.
Hw	**Fresh water wetlands** - Wetland areas where the water table is at or near the land surface and organic-rich sediment accumulates.
Qed	**Sand dunes** - Well-sorted fine to medium sand deposited as dunes by the action of wind.
Qst	**Stream-terrace deposits** - Fine to coarse sand and gravel deposits on terraces and next to modern streams, eroded into older glacial meltwater deposits.
Pld, Plb	**Glacial-lacustrine deposits** - Sediments which accumulated in glacial lakes. Includes deltas and lake-bottom deposits. In general, delta topsets are coarse sands and gravels; foresets are coarse to medium sand and bottom sediments are fine sands and silts. Pllpd - Delta deposits associated with Long Pond stage. Plspd - Delta deposits associated with the Spruce Pond stage. Plspb - Lake bottom deposits associated with the Spruce Pond stage. Pld - Deltaic glacial lake deposits in the Saco River valley at east border of quadrangle. Plcd - Delta deposits associated with Lake Cornish stage. Plcb - Bottom deposits associated with the Lake Cornish stage. Plsd - Delta deposits associated with the Saco stage. Plpd - Delta deposits associated with Lake Pigwacket stage.
Pg	**Glacial-fluvial sand and gravel deposits** - Sand and gravel deposited by glacial meltwater streams. Pgs - Saco River system Pgpb - Pugsley Brook system Pgbb - Breakneck Brook system Pgsp1-2 - Spruce Pond system
Pgi	**Ice-contact deposits** - Scattered deposits of well-sorted sand and gravel which were formed by meltwater streams flowing between glacial ice and emergent hills.
Pge	**Esker deposits** - Sand and gravel deposited by meltwater streams flowing through subglacial tunnels. Form narrow ridges up to 100 ft. high. Pgesp - Spruce Pond system Pgepb - Pugsley Brook system
Pem	**End moraines** - Morainal ridges composed of glacial till, marking an ice marginal position.
Pt	**Till** - An unsorted, unstratified, mixture of materials ranging from boulders and cobbles to sand, silt, and clay. Material ranges from semiconsolidated to loose.
	Bedrock and thin drift - Gray areas are individual outcrops. Ruled pattern indicates areas where surficial sediments are generally less than 10 ft thick.
	Geologic contact - Boundary between surficial geologic units. Dashed where location is uncertain.
	Streamlined hill - Elongated hill or till ridge with long axis oriented parallel to ice flow direction. Includes drumlins and roche moutonées.
	Meltwater channel - Channel cut by meltwater stream or glacial lake outflow. Arrow indicates inferred direction of flow.
	Erosional scarp - Steep slope cut by a stream channel. Includes both meander scars along modern streams and the margins of broad glacial meltwater channels cut in older stratified drift. Relative age of meltwater channel indicated by number in some areas. Direction of meltwater flow indicated by arrow.
>>>>>	**Esker ridge** - Shows trend of sand and gravel ridge deposited in a meltwater tunnel within or beneath glacial ice. Chevrons indicate direction of meltwater flow.
	Ice-margin position - Position of the ice margin at a particular time during stagnation-zone glacial retreat.
	Varve location - Outcrop of varves (annual couplets of sandy silt and clay deposited in the bottom of a glacial lake).
135	**Striations** - Striations on the bedrock surface showing the local direction of glacial ice flow. Where two directions are present, flagged trend is older.
	Boulders - Area of numerous large boulders.

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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