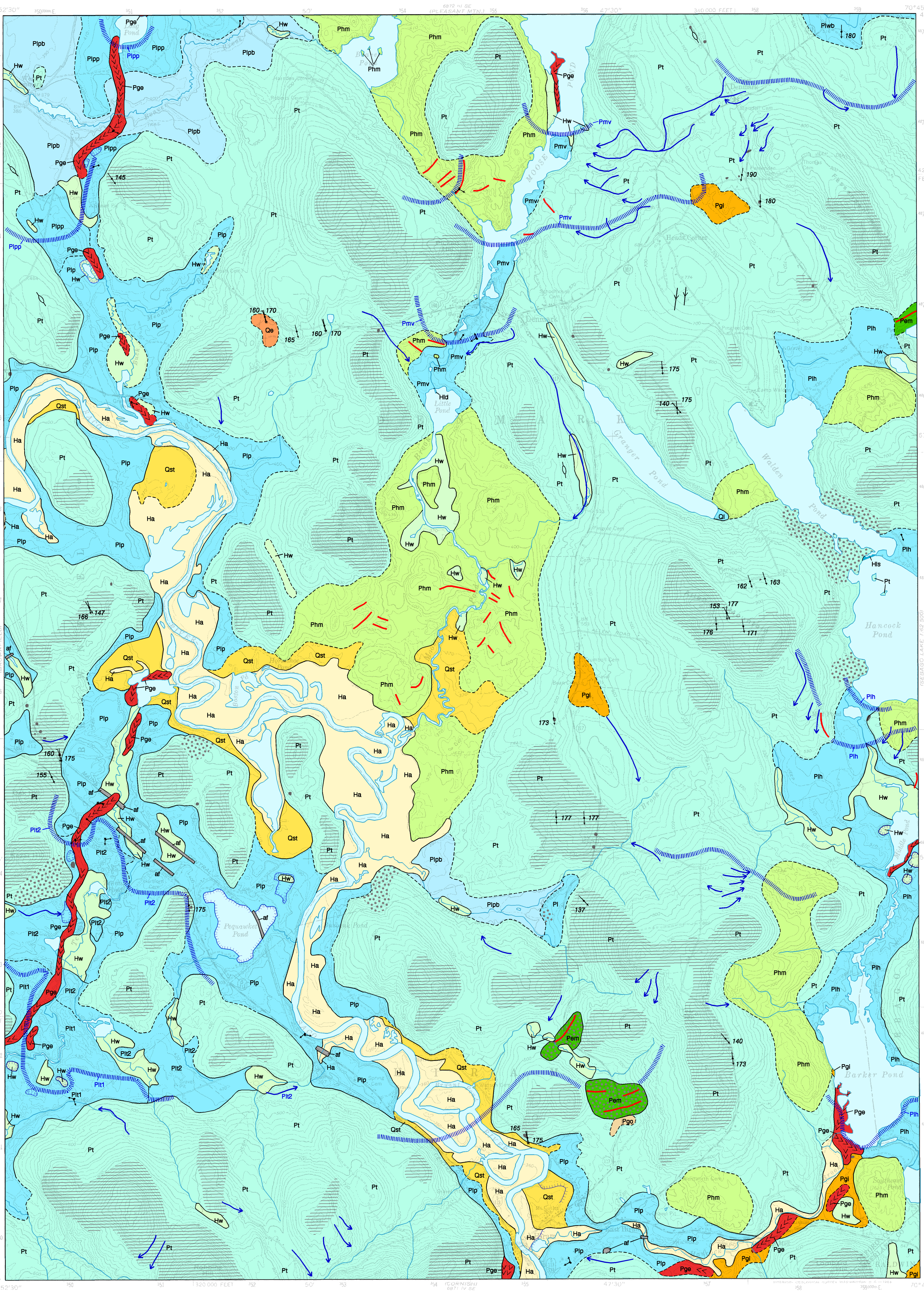
Surficial Geology



Hiram Quadrangle, Maine

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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 Hiram 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 Woodrow B. Thompson completed during the 1994-1995 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 Hiram 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.

Ha — **Stream alluvium** - Sand, silt, gravel, and organic material. Deposited on flood plains of modern streams.

Hw — **Wetland deposits** - Peat, muck, and fine-grained inorganic sediments. Deposited in poorly drained areas.

Hls — **Beach** - Narrow sand and gravel deposits formed by wave and current action on modern lakeshores. Mapped only at north end of Hancock Pond, but may be expected to occur elsewhere, especially where shorelines have formed on glacial sand and gravel.

Hld — **Lacustrine delta** - Sediments deposited where Moose Pond Brook enters Little Pond.

Ql — **Lake deposits** - Lacustrine sediments of uncertain age at southeast end of Granger Pond.

Qe — **Eolian deposits** - Windblown sand. May occur as dunes or irregular blanket deposits.

Qst — **Stream-terrace deposits** - Sand and gravel deposited on former flood plains of the Saco River as it cut down to its present level.

Plpp, Plp, Plpb — **Lake Pigwacket deposits** - Sand gravel, and silt deposited in Lake Pigwacket, which occupied the Saco Valley in late-glacial time.

Plpp - Pleasant Mountain stage deposits - Sediments deposited in Lake Pigwacket when it was at its highest level (~440 ft elev.) in the northwest part of the quadrangle. Unit includes ice-contact deltas and subaqueous fans.

Plp - Undifferentiated Lake Pigwacket deposits - Sediments deposited in the Saco Valley, where the lake level stood at 410-430 ft. Unit includes abundant deltaic deposits, which locally have been eroded by the postglacial Saco River.

Plpb - Lake-bottom deposits - Sand and silt deposited on the floor of Lake Pigwacket.

Pl — **Undifferentiated lake deposits** - Sand and silt deposited in small glacial lake in Dragon Meadow Brook valley. Probable spillway for this lake is located about 0.5 mile south of unit Pl.

Pmv — **Moose Pond valley deposits** - Deltaic and fluvial sand, gravel, and silt deposited in a glacial lake in the Moose Pond valley. Lake level stood as high as 440-450 ft, but probably dropped to about 430 ft as ice melted from the valley.

Plwb — **Willett Brook deposits** - Ice-contact glaciolacustrine(?) sand and gravel deposited in the upper part of Willett Brook valley. Unit extends north and east into the adjacent quadrangles.

Plt$_2$, Plt$_1$ — **Glacial Lake Tenmile deposits** - Sand and gravel deposited in a glacial lake in the Tenmile River valley. Mostly deltaic, but probably includes some fluvial deposits.

Plt$_2$ - Deposits associated with lower level of the lake, at elevation of about 440 ft. This lake stage drained east into the Saco Valley.

Plt$_1$ - Deposits formed when lake level stood at 470-480 ft and drained southward through a spillway at the head of Tenmile Valley (in Kezar Falls quadrangle).

Plh — **Glacial Lake Hancock deposits** - Deltaic sand and gravel deposited in a glacial lake that occupied the valley extending north and south from Hancock Pond. Delta tops indicate lake level of about 510-530 ft (higher to north due to crustal tilt).

Pgo — **Glacial outwash** - Sand and/or gravel deposited in front of moraine cluster north of Hiram village.

Pgi — **Ice-contact deposits** - Undifferentiated sand and gravel deposits formed in contact with melting glacial ice.

Pge — **Esker deposits** - Sand and gravel deposited by meltwater streams in glacial tunnels. Unit may also include some tunnel-mouth lacustrine fan deposits. Chevrons indicate inferred direction of stream flow.

Phm — **Hummocky moraine** - Glacial till with hummocky topography. Usually contains many boulders. Lenses of sand, gravel, and silt are locally abundant. Unit also includes moraine ridges that probably formed at the glacier margin during recession of the last ice sheet.

Pem — **End moraine** - Very bouldery till ridges deposited at the glacier margin in the valley north of East Hiram and north of Perley Pond.

Pt — **Till** - Loose to very compact, poorly sorted, mostly nonstratified mixture of sand, silt, and gravel-size rock debris deposited by glacial ice. Locally contains lenses of water-laid sediment.

af — **Artificial fill** - Mixtures of till, gravel, sand, clay, and/or artificial materials transported and dumped to form elevated sections of roadways and other filled areas.

Bedrock - Gray areas are individual outcrops. Ruled pattern indicates areas where outcrops are common and/or surficial sediments are generally less than 10 ft thick.

Boulders - Areas of numerous large boulders.

Contact - Boundary between map units. Dashed where location is very approximate.

Scarp - Scarp separating higher and lower terrace levels in a single map unit.

Ice marginal position - Line shows an approximate position of part of the glacier margin during ice retreat, based on ice-contact topography, end moraines, and/or meltwater channels. Letter symbol indicates map unit deposited (at least in part) from this position.

Moraine ridge - Line shows crest of moraine ridge in area mapped as till or hummocky moraine.

Glacially streamlined hill - Symbol shows trend of long axis, which parallels former ice-flow direction.

135 **Glacial striation locality** - Arrows show ice-flow directions (azimuths in degrees) inferred from striations (scratches on bedrock caused by glacial abrasion). Dot marks point of observation. Flagged trend is older.

Dip of cross-bedding - Dip direction(s) of cross-bedding in fluvial or deltaic deposits. Indicates direction of stream flow or delta progradation. Dot marks point of observation.

Kettle - Depression created by melting of buried glacial ice and collapse of overlying sediments.

Meltwater channel - Channel eroded by glacial meltwater stream or drainage from glacial lake. Arrow shows inferred direction of former stream flow. Accompanying map unit symbol (where present) indicates glacial lake stage for which the channel served as an outlet.

Grooved till surface - Narrow ridges carved in till by flow of glacial ice. Inferred ice flow directions are shown by arrowheads.

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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