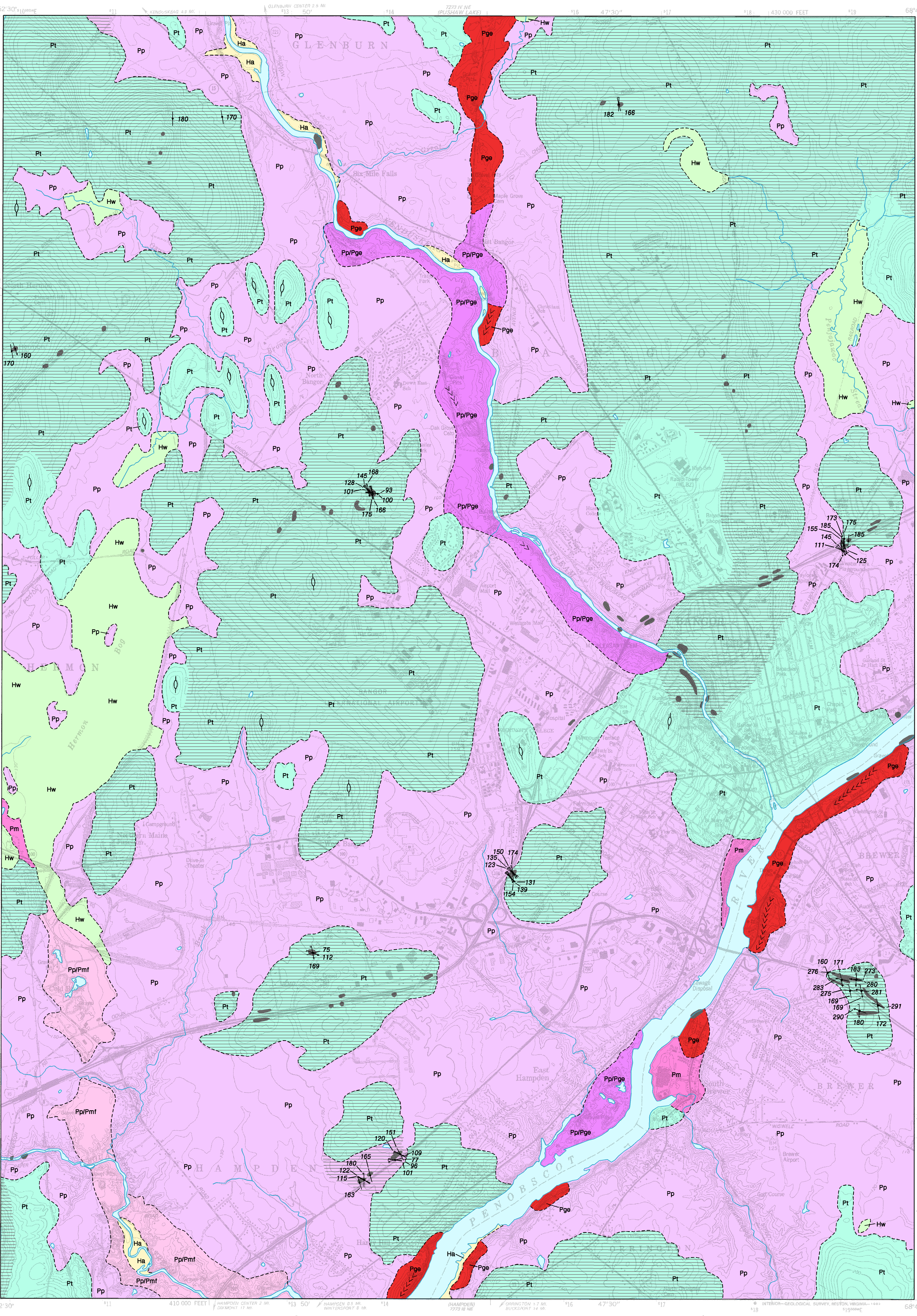
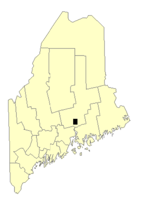
Surficial Geology



SOURCES OF INFORMATION

Surficial geologic mapping of the Bangor quadrangle was conducted by Kent M. Syverson and Andrew H. Thompson in 2007 for the STATEMAP program and modified by 2009 field data.



Quadrangle Location

SCALE 1 : 24,000

CONTOUR INTERVAL 20 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Bangor 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.

Bangor Quadrangle, Maine

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This map supersedes Open-File Map 10-2.

For additional information, see Open-File Report 08-52.

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 Bangor 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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Davis, R. B., and Jacobson, G. L., Jr., 1985, Late-glacial and early Holocene landscapes in northern New England and adjacent areas of Canada: Quaternary Research, v. 23, p. 341-368.

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Ridge, J. C., 2004, The Quaternary glaciation of western New England with correlations to surrounding areas, *in* Ehlers, J., and Gibbard, P. L., eds., Quaternary Glaciations – Extent and Chronology, Part II: North America: Amsterdam, Elsevier, p. 169-199.

Figure 1. Thin till overlying glacially eroded bedrock on Route 17 in Township D. Most till in the Bangor quadrangle is quite thin over the bedrock surface.

Figure 2. Ablation till over basal melt-out till near Phillips, Maine. The lower, more uniform basal unit was deposited directly by glacier ice and is typical of the glacial till in the Bangor quadrangle. The upper cobble- and boulder-rich sediment melted out on top of the glacier and was sorted by water and gravity processes.

Figure 3. Boulder to pebble gravel (right side) deposited in the ice tunnel. This esker sediment is overlain by more glaciomarine sediment (upper left side) interbedded with coarse material that slumped off the esker during recession of the ice margin. The gravel pit is located south of China Lake, Maine.

Figure 4. Fossil mussel shells washing out of silt and clay of the glaciomarine Presumpscot Formation, East Hampden, Maine.

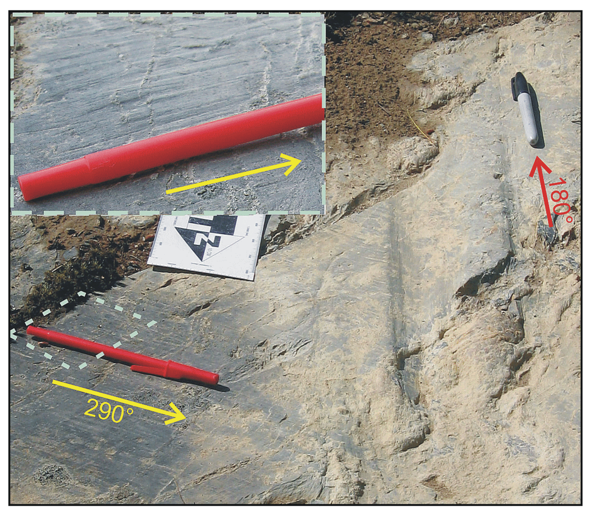

Figure 5. Large crag-and-tail features cut by younger erosional marks at the intersection of Interstate Highway 395 and Parkway South in Brewer. Older grooves and crag-and-tail features represent southerly flow during the ice-flow maximum (180° azimuth). Younger striae and crag-and-tail features (inset photo) indicate an ice-flow direction to the west-northwest (290° azimuth). The younger, secondary flow directly toward the Penobscot River valley is evidence for a calving embayment.

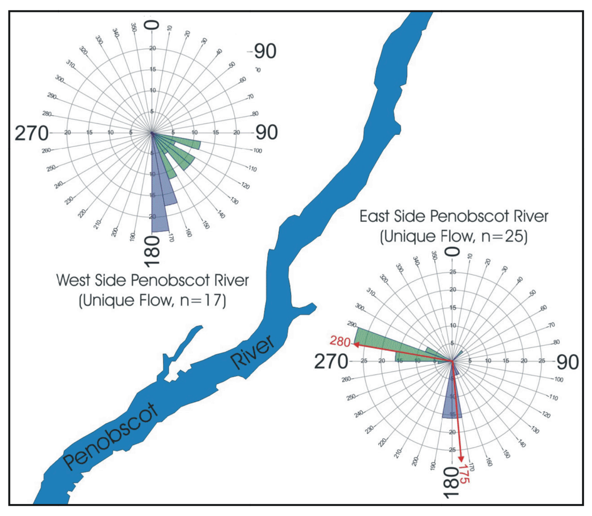

Figure 6. Rose diagrams showing convergent flow along the axis of the Penobscot River lowland. Areas west and east of the river have numerous crag-and-tail features recording ice flow approximately north-south (175° azimuth vector mean) during the flow maximum. West of the river, a continuous set of striations and crag-and-tail features show flow becoming more easterly as deglaciation proceeded. East of the river, a sudden flow change from south to west-northwest (280° azimuth vector mean) is recorded by two discrete data sets lacking intermediate flow indicators. Numbers along cardinal axes are percentage of total data. Convergent, secondary flow patterns in this area with gentle bedrock slopes are evidence for a calving embayment in the Penobscot River valley.

Ha	**Stream alluvium** - Sand, gravel, and silt deposited on flood plains of streams. May include some wetland deposits.
Hw	**Wetland sediment** - Peat, muck, silt, and clay in poorly drained areas.
Pp	**Presumpscot Formation** - Glaciomarine silt, clay, and sand deposited on the late-glacial sea floor.
Pp/Pge	**Presumpscot Formation overlying esker sediment** - Areas of sand and gravel (Pge) deposited by glacial meltwater streams in tunnels beneath the ice. After tunnel sediment was exposed during recession of the ice sheet, then a variable thickness of glaciomarine silt, clay, and sand (Pp) was deposited above the esker sediment. The Presumpscot Formation tends to thicken away from the esker crest. These units could not be distinguished accurately at the scale of the map because of complex interrelationships and limited fresh exposure.
Pp/Pmf	**Presumpscot Formation overlying glaciomarine fan sediment** - Glaciomarine silt, clay, and sand (Pp) overlying submarine fan sediment (Pmf) containing well stratified sand and gravel.
Pm	**Pleistocene glaciomarine deposit** - undifferentiated; may consist of gravel, sand, silt, or clay or any combination, deposited during marine regression. May drape glacial marine fan or esker deposits.
Pge	**Esker** - Sand and gravel deposited by glacial meltwater streams in tunnels beneath the ice. Chevron symbols show inferred direction of former stream flow.
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. Locally includes lenses of waterlaid sand and gravel. Boulders commonly present on ground surface.
	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 small individual outcrops.
	Contact - Boundary between map units, dashed where approximate.
	Glacially streamlined hill - Symbol shows long axis of hill or ridge shaped by flow of glacial ice, and which is parallel to former ice-flow direction.
135	**Glacial striation locality** - Arrow shows ice-flow direction inferred from striations on bedrock. Dot marks point of observation. Number is azimuth (in degrees) of flow direction. Flagged trend is older.
>>>>>	**Crest of esker** - Alignment of symbols shows trend of esker ridge. Chevrons point in direction of meltwater flow.

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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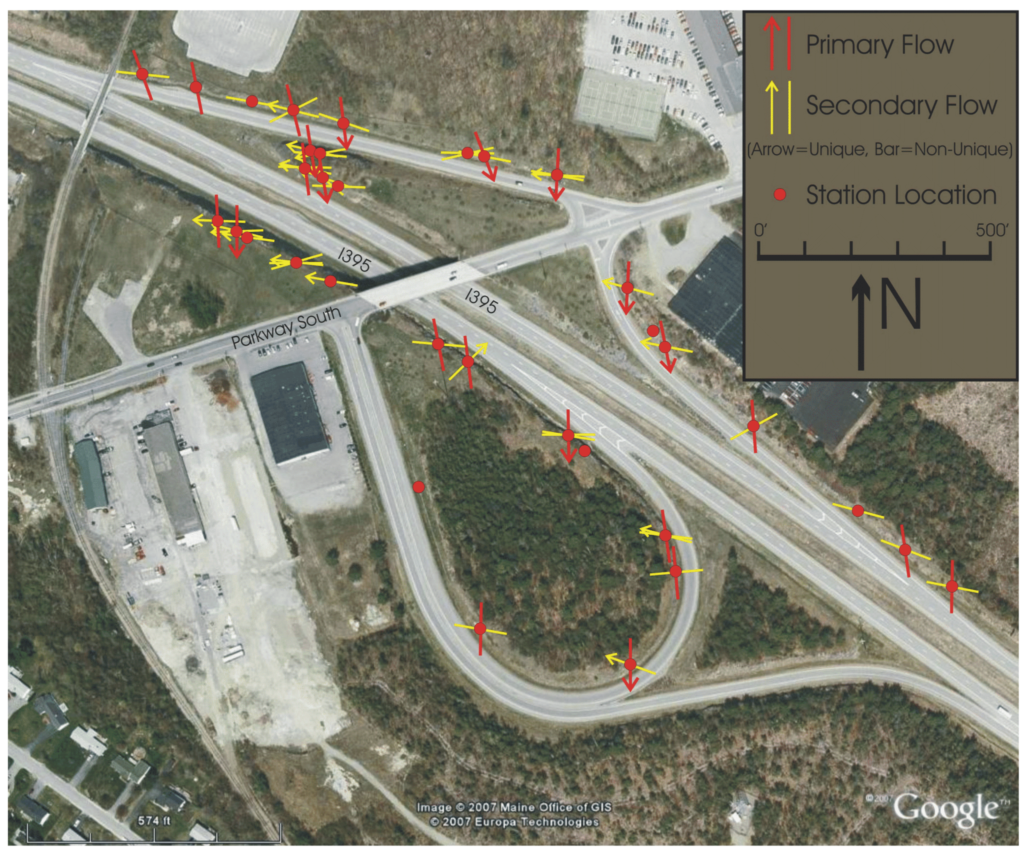

Figure 7. Detailed ice-flow indicator measurements at the Interstate 395/Parkway South interchange in Brewer, Maine. The ice-flow direction during the glacial maximum was southerly (175° azimuth vector mean). Then ice-flow changed to the west-northwest (280° azimuth vector mean, toward the river lowland). Few intermediate flow indicators are observed between the two sets, suggesting a rapid change in flow direction. Base image from Google Earth™ mapping service.