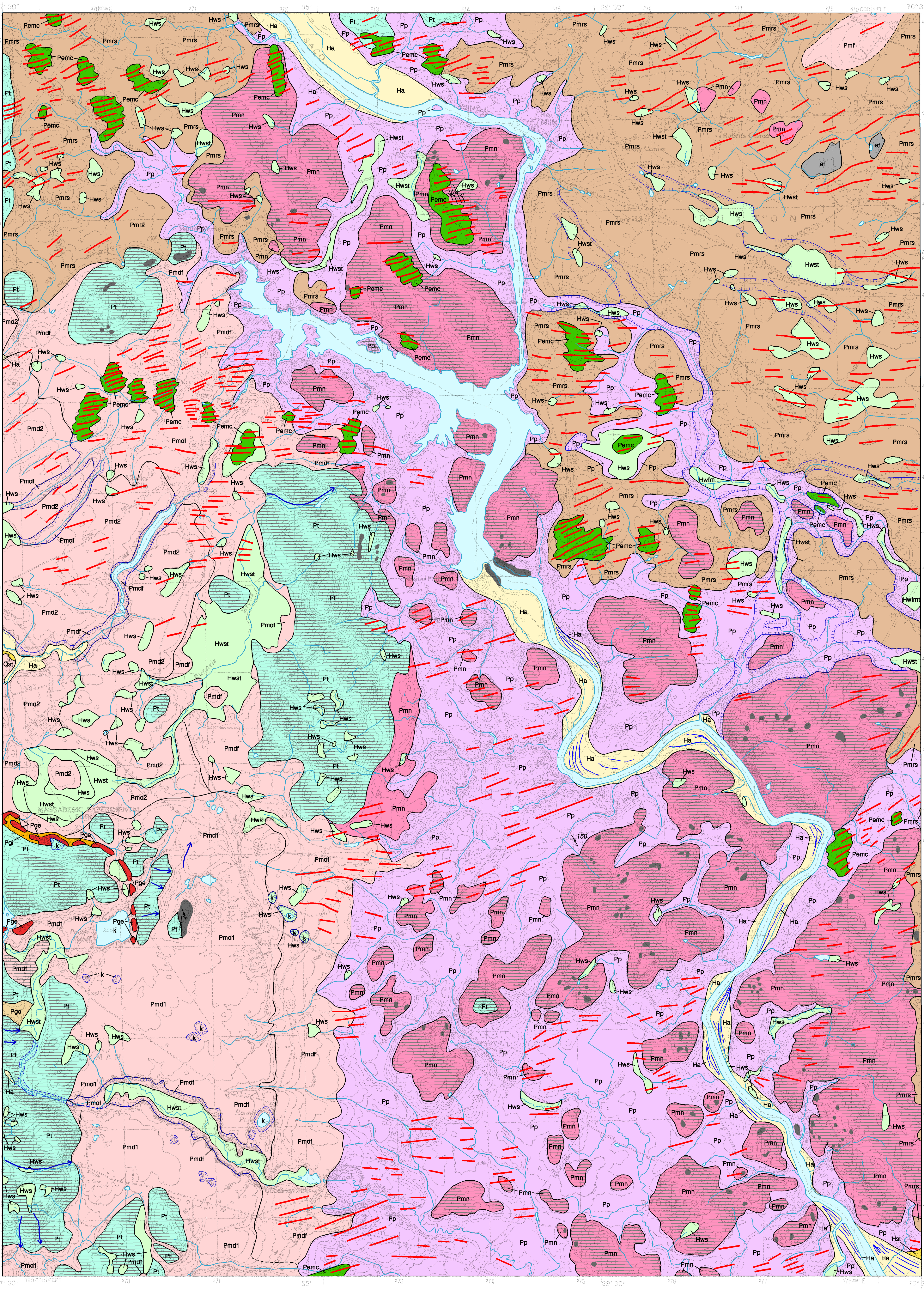
Surficial Geology



Bar Mills 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 Bar Mills 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.

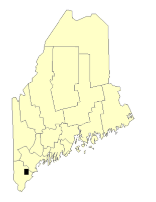
Figure 6: Aerial view of moraine ridges in blueberry field, Sedgwick (note dirt road in upper right for scale). Each bouldery ridge marks a position of the retreating glacier margin. The ice receded from right to left.

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 Lewis E. Hunter completed during the 1987 field season; funding for this work provided by the U. S. Geological Survey COGEOMAP program. Wetlands data provided by Cornelia C. Cameron, U.S. Geological Survey, 1988. Geologic unit designations and contacts revised and matched to adjacent quadrangles in 1999 by MGS geologists.



Quadrangle Location

SCALE 1 : 24,000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 10 FEET

TRUE NORTH

Topographic base from U.S. Geological Survey Bar Mills 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.

Explanation of units and symbols

- **Ha** — **Alluvium** - Well-sorted and stratified sand, silt, and gravel. Comprises flood plains along present streams and rivers.
- **Hws** — **Swamps*** - Muck, peat, silt, and sand (undifferentiated) in poorly drained areas. Commonly associated with standing water.
- **Hwfm** — **Freshwater marsh*** - Poorly drained freshwater grassland.
- **Hst**, **Qst** — **Stream terrace deposits** - Sand and gravel deposited on former flood plains in late-glacial (Qst) or postglacial (Hst) time.
- **Pmn** — **Nearshore deposits** - Generally poorly-sorted mixture of silt, sand, and gravel formed by wave reworking of glacial sediments during marine regression. Variable thickness; generally less than 3 m. Associated with paleobathy metric high.
- **Pmrs** — **Marine regressive sand deposits** - Massive to stratified, well-sorted, gray to yellow-brown sand. Overlies Pp with gradational or interfingering transition zone. Deposited through reworking of older glacial sediments during regressive phase of marine submergence.
- **Pp** — **Presumpscot Formation** - Laminated to massive, gray to green-gray silt and clay. Occurs as a blanket deposit of variable thickness from 0 to 50 meters over older glacial deposits. May locally contain boulders, sand, and gravel. Deposited during period of late-glacial marine submergence.
- **Pgo** — **Glaciofluvial outwash** - Stratified sand, gravel, and some silt deposited by glacial meltwater streams.
- **Pmd**, **Pmd1**, **Pmd2** — **Glaciomarine delta (undifferentiated)** - Generally stratified fine to coarse sand and gravel. Surface topography is flat or slopes gently away from the paleoice margin. Formed by glacial streams discharge into late-glacial sea. Commonly exhibit kettles at the head-of-outwash marking former ice position.
  - **Lyman Delta sequence**: Glaciomarine delta sequence that constitutes first morphologic sequence in Bar Mills quadrangle. Deposited while ice margin was located at the southern portion of the Massabesic Experimental Forest. The delta was fed by a chain of beaded eskers.
  - **Hollis Delta sequence**: Second morphologic sequence, deposited while the ice margin was located in the vicinity just south of Bear Hill. The delta was fed by an esker chain to the west near the town of Waterboro.
- **Pmdf** — **Glaciomarine delta foresets** - Steeply dipping (10-35°) stratified sand and gravel that grades into Pp down slope. Located along the seaward margin of Pmd, where the delta front slopes eastward, and also exposed where channels have been eroded in the deltas. The topset-foreset contact occurs at approximately 80 m above present sea level, marking the maximum limit of marine submergence.
- **Pmf** — **Glaciomarine fan** - Sand and gravel deposited in the sea as subaqueous fans at the margin of the last glacial ice sheet.
- **Pemc** — **End moraine complex** - Coarse till, gravel, sand, and silt associated with ridges and mounds that formed at or near the front of a retreating marine-based glacier. Mapped in areas of closely spaced (DeGeer) end moraines. Sediments are commonly deformed.
- **Pge** — **Esker** - Sinuous ridges comprised of stratified, coarse sand and gravel. Commonly found at the heads of large glaciomarine deltas (Pmd). Deposited in subglacial and englacial meltwater tunnels.
- **Pgi** — **Ice-contact deposits** - Sand and gravel deposited adjacent to glacial ice.
- **Pt** — **Till** - Poorly sorted mixture of gray to gray brown silt, sand, and gravel. Forms a blanket deposit over bedrock and is inferred to underlie younger sediments where not exposed at the surface. Commonly less than 3 m thick over bedrock highs.
- **Bedrock outcrops/thin-drift areas** - Ruled pattern indicates area where surficial sediments are generally less than 3 m thick. Gray areas and dots show individual outcrops.
- **af** — **Artificial fill** - man-made landfill.
- **Contact** - Boundary between map units. Dashed where very approximate.
- **Flutes** - Arrows indicate inferred flow direction of glacial ice (observed on aerial photos).
- **Scarp** - Miscellaneous stream and river escarpments.
- **Moraine crest** - Linear or sinuous moraine ridges outcropping below the marine limit. Composed of till, gravel, sand, and silt deposited at or near margin of retreating glacier. Barbs point in direction of former ice flow.
- **k** — **Kettle** - Circular depressions in drift formed by ice-block meltout.
- **Meltwater channel** - Channel eroded by glacial meltwater stream. Arrow shows inferred direction of former stream flow.
- **Meander scrolls** - Flood plain deposits (observed on aerial photographs).
- **135** — **Ice flow indicators** - Azimuth of glacial striations and roches moutonées.
- **135** — **Ice flow indicators** - Azimuth of crescentic gouges

*NOTE: Wetland symbols followed by "t" indicate areas where peat deposits probably do not constitute a significant commercial resource, either because they are thin (< 1.5 m), or they have an ash content greater than 25 percent. Symbols followed by "p" indicate peat deposits that are thicker (generally > 1.5 m), with ash content less than 25 percent, and thus may be suitable for commercial applications.

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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