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Surficial Geology of the Lewiston 7.5-Minute Quadrangle, Androscoggin County, Maine

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INTRODUCTION

This report describes the surficial geology and Quaternary history of the Lewiston quadrangle in southwestern Maine. Surficial earth materials include unconsolidated sediments (sand, gravel, etc.) of glacial and nonglacial origin. Most of these deposits formed during and after the latest episode of glaciation in Maine, called the Wisconsinan glaciation, starting about 25,000 years ago.

Surficial sediments cover the bedrock over most of the quadrangle and are subject to many uses and environmental considerations. These include sand and gravel extraction, development and protection of groundwater supplies, siting of waste disposal facilities, and agriculture (Thompson, 2001).

The field work for this study was carried out in 2001 for the STATEMAP cooperative between the Maine Geological Survey and the U.S. Geological Survey (USGS). Two maps are associated with this report. The *geologic map* (Hildreth, 2002b) shows the distribution of sedimentary units and indicates their age, composition, and known or inferred origin. It also includes information on the geologic history of the quadrangle, such as features indicating the flow direction of glacial ice. This map provides the basis for the following discussion of glacial and postglacial history.

The *materials map* (Locke and Hildreth, 2002) shows specific data used to help construct the geologic map. These data include observations from gravel pits, shovel and auger holes, construction sites, and natural exposures along stream banks. The materials map also shows boring and well logs. Sand and gravel aquifer studies by the USGS provided additional data on the type and thickness of surficial sediments in the quadrangle (Prescott, 1967, 1968).

Geographic Setting

The Lewiston 7.5-minute quadrangle has an area of about 133 km^2 (52 mi^2). It is located in southwestern Maine, near the approximate border of the White Mountain foothills (a.k.a. Oxford Hills) and the Seaboard Lowland physiographic province, about 42 km (27 mi) north of Portland. It includes parts of the towns of Lisbon, Durham, and Webster, and parts of the cities of Auburn and Lewiston. Altitudes range from just above 30 m (100 ft), which is the level of the Androscoggin River where it flows south at the south edge of the quadrangle, to over 162 m (550 ft) at Woodbury Hill near the southwest edge of the quadrangle.

Many ridges in the Lewiston quadrangle were shaped by glacial ice flowing south-southeast to south-southwest and have been elongated in that direction. The topography in the study area is also controlled by folding in the Silurian metasedimentary rocks.

The major stream drainage in the quadrangle is the south-flowing Androscoggin River that roughly bisects the quadrangle in a south-southeast direction, and which has one large tributary in the quadrangle—the Little Androscoggin River, which joins it in the northwest part of the quadrangle in downtown Auburn. Several smaller tributaries include the outlet stream of Lake Auburn (north of the quadrangle), which leaves the lake at its east end and flows south to join the Androscoggin near the northwest edge of the Lewiston quadrangle; Jepson Brook, which drains Garcelon Bog in the north-central part of the quadrangle; Soper Mill and House Brooks which drain parts of the southwest area into the Androscoggin; and Salmon, Moody, and Hart Brooks (and smaller unnamed streams)—which drain parts of the eastern side of the Androscoggin in the quadrangle. No Name Brook and its tributaries flow southward from the northeast edge of the quadrangle and drain the northeastern part of the area, finally flowing east just north of Route 196 in South Lewiston to join the south-flowing Sabattus River east of the quadrangle. The Sabattus meets the Androscoggin near the south edge of the Lisbon Falls North quadrangle. Meadow Brook and its tributaries drain the southwesternmost part of the quadrangle toward

the southwest into the south-flowing Royal River in the Gray quadrangle.

Bedrock Geology

Much of the map area is underlain by folded metapelite, metasandstone, and metalimestone of the Silurian Sangerville and Waterville Formations and the Silurian-Ordovician Vassalboro Formation, intruded in places by small stocks of Devonian granite (Osberg and others, 1985) and pegmatite dikes. The Patch Mountain Member of the Sangerville has thin interbeds of calc-silicate assemblages and biotite granofels (Creasy, 1979). Outcrops and detached fragments of this rock unit weather unevenly, producing a distinctive ribbed surface ("ribbon rock").

PREVIOUS AND CURRENT WORK

Early work on the surficial geology in this part of Maine was done generally at a reconnaissance level and at a smaller scale (Prescott, 1968; Smith and Thompson, 1980; Thompson and Borns, 1985). Significant sand and gravel aquifers were mapped by Prescott (1967, 1968). The soil survey of Androscoggin County (McEwen, 1970) and recent surficial materials map (Locke, 1999) facilitated field work. Surficial geologic mapping has been completed at the 1:24,000 scale in several adjoining quadrangles, including Gray (Weddle, 1997a,b), Lake Auburn East (Hildreth, 2002a), Lake Auburn West (Thompson, 2001), Lisbon Falls North (Weddle and others, 1999), Lisbon Falls South (Weddle, 1997c), Minot (Hildreth, 2001), Monmouth (Foley, 2002), and North Pownal (Marvinney, 1999).

GLACIAL AND LATE-GLACIAL HISTORY

Southwestern Maine probably experienced several episodes of glaciation during the Pleistocene Ice Age, but virtually all evidence of previous glaciations in the Lake Auburn East area was obliterated during the last (late Wisconsinan) episode, when the Laurentide ice sheet advanced from the northwest to a terminal position on the continental shelf.

Evidence of glacial erosion within this area is noticeable mainly as southeast- to southwest-trending glacial striations on freshly exposed bedrock surfaces. Several locations contained more than one set of striations. In most cases where it was possible to determine relative ages of the different striation sets, the southeast set was the older and the southwest set the younger. In one location south of Cottage Road near the center of the map, 3 sets were measured on one outcrop, with the oldest set bearing 168-186 degrees, the next younger bearing 205 degrees, and the youngest set bearing 220 degrees. In this and some other locations, the steep northwest-facing slope of the local bedrock surface that the south-southeast-flowing continental ice mass encountered may have served as a barrier to divert the flow from the general southeast direction to at first a southerly direction and later, more and more southwesterly. Probably the diversions occurred during the waning stages of glaciation. Further, more detailed, investigations of these striations, in this and adjoining areas, may help in efforts to decipher the changes in glacial flow more precisely during the last stages of glaciation in this part of Maine.

In the Lewiston area there are few drumlins; the best examples are in the southwest part of the quadrangle near Steel and Soper Mill Roads. However, several streamlined hills that have bedrock cores are elongated in a south-trending direction. Examples are the northern end of Apple Sass Hill and the hill west of South Maine Street in New Auburn in the central section of the map area.

After reaching its terminal position on the continental shelf, the late Wisconsinan ice sheet began to recede between 15,000 and 17,000 years ago. Shells collected from glaciomarine sediments deformed by ice shove in the Freeport area (southeast of Lewiston) have a radiocarbon age of 14,045 yr B.P. (Weddle and others, 1993). The ice sheet terminus is inferred to have withdrawn to the Lewiston area a short time after that. As the ice sheet melted northward, sea level rose and inundated the entire Maine coastal zone, including much of the area in the Lewiston quadrangle lying below a current elevation of approximately 350 ft above sea level, which is at the limit of maximum marine submergence for this part of Maine. As summarized by Thompson and Borns (1985), the marine submergence reached its maximum extent at about 13,000 yr B.P. and regressed from the area somewhat before 11,450 yr B.P. (Smith, 1985; Thompson and Borns, 1985), based on radiocarbon-dated fossil shells that indicate the approximate offlap of the late-Wisconsinan sea at Little Falls, Gorham, about 42 km (27 mi) southwest of the Lewiston quadrangle.

"An unrecorded radiocarbon date of 13,300 $\pm$ 50 yr B.P. (OS-4419) on *Mytilus edulis* from nearshore deposits in a pit at approximately 200 feet (61 m) asl in the adjacent North Pownal quadrangle records the earliest date for marine regression in the state. A younger date (12,820 $\pm$ 120 yr B.P., SI-7017) on in-situ intertidal fauna is reported by Retelle and Bither (1989) from nearshore deposits at an elevation of 152 feet (46 m) asl in a gravel pit in Topsham (Brunswick 7.5-minute quadrangle). An uncorrected date of 13,315 $\pm$ 90 yr B.P. (AA10162: Weddle and others, 1993) from the same pit in Topsham on *Portlandica arctica* shells found in Presumpscot Formation mud approximately one meter below the nearshore deposits containing the interidal fauna supports the older offlap dates" (Weddle, 1997d, p. 8).

As sea level dropped, many of the materials deposited below the level of the late-glacial sea in the Lewiston area became reworked by wave action as their surfaces passed through the swash zone; they formed characteristic nearshore and shoreline deposits in places. Further lowering of sea level led to downcutting of earlier outwash deposits by the late-glacial Androscoggin River and its larger tributaries, which built a relatively broad in-

cised braided stream channel (Pa) within the main stem of the river valley. At approximately the same time, and probably somewhat later, the now-exposed sandy marine sediments became eroded by wind action, which transported and sorted them into various dune deposits (Qe) in the area.

GLACIAL AND POSTGLACIAL DEPOSITS

As the ice sheet melted in the Lewiston area, it dropped much of the debris incorporated within it in the form of till. At the same time and somewhat later, glacial meltwaters took some of the debris within the glacier, sorted it, carried it some distance, and finally deposited it as huge volumes of stratified sediments in various physiographic settings within the quadrangle. These settings are referred to as environments of deposition. Most of the deposits delineated on the map (Pleistocene, Quaternary, and Holocene) are characterized on that basis. A few deposits are distinguished by the agent of deposition, such as till (Pt), for which the ice is the agent of deposition, and eolian deposits (Qe) for which the wind is the agent. Postglacial deposits include materials laid down since the glacier melted north of the Lewiston area and sea level dropped well below the surfaces that it previously covered here. The postglacial sediments include materials mapped as Quaternary in age: that may have been continuously deposited since the recession of the sea from the area; that may have been deposited during a time that spanned the Pleistocene - Holocene boundary; or that may have been deposited in either Pleistocene or Holocene time. Holocene deposits are commonly referred to as recent or modern deposits; they were laid down within the last 10,000 years and most are still in the process of deposition.

The succession of Pleistocene and Holocene surficial deposits in the Lewiston area is given in the correlation chart (Figure 1) showing the relative ages of the map units.

Till (unit Pt)

Till occurs throughout the Lewiston area. Its thickness is variable, as is its composition. The till was deposited from the glacial ice sheet and forms a blanket over the underlying bedrock; it is inferred to underlie younger deposits throughout the area. In most exposures in the quadrangle, this till is light olive-gray, sandy, stony, and moderately compact, showing weathering only in the uppermost few feet.

Some drumlins are found in the area, but most hills that are drumlin-shaped (and oriented in the expected direction for drumlins relative to the direction of striations in the area) have bedrock cores that have been plastered with till. Many more of these rock-cored hills exist in the quadrangle than do true drumlins. Though most till is less than 6 meters (20 ft) thick in the area, several wells in the southern part of the map area penetrated at least 18 meters (60 feet) of probable till.

Esker deposits (unit Pge)

In the central part of the map, an esker deposit extends southward into marine delta deposits (Pmdia) underlying the Armory area. This short ridge of sand and gravel was deposited by meltwater streams flowing south-southeast in a tunnel in the bottom of the last ice sheet; where the tunnel opened out at the snout of the glacier, meltwaters deposited the marine delta contemporaneously with the esker. In places, the esker ridge is bordered by depressions (kettles) left when masses of glacial ice melted. It is inferred to be a segment of a more extensive esker deposit that is buried by younger deposits in the area. For example, a gravel pit about 1.5 miles (2.4 km) south of the north end of the mapped esker segment contains 25 feet (about 8 m) of fine to medium sand mapped as marine nearshore deposits (Pmn) overlying 36 feet (about 11 m) of pebble-cobble gravel which is interpreted as a buried part of the esker.

The esker deposit is inferred to be part of a branching esker system that can be traced from Sumner to the north, discontinuously south to this area. "Whether meltwater flowed simultaneously through this entire tunnel network is debatable, but it is likely that the esker segments formed progressively from south to north as the tunnel became clogged with sediment during deglaciation" (Thompson, 2000).

The exposed part of this esker segment is more than 50 ft (15 m) high, but in many places it is more or less buried by adjacent younger outwash and modern alluvial deposits. Most subsurface data indicate a maximum depth of less than 70 ft (21m). Pits contain mostly sand to pebble-cobble gravel, with occasional boulders. The esker is useful as a source of sand and gravel and as a municipal aquifer (Prescott, 1968).

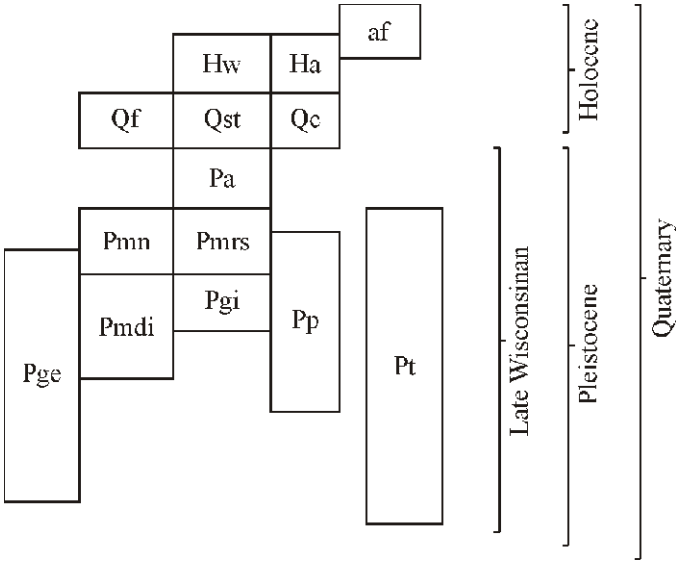

Figure 1. Correlation of map units, Lewiston quadrangle.

Undifferentiated ice-contact deposits (unit Pgi)

Small isolated areas of thin glaciofluvial outwash and/or ice-contact deposits consisting of sand, gravel, and silt were identified in the northeast part of the quadrangle. These may include esker or glaciomarine fan deposits. These deposits are useful as a source of sand and gravel.

Glaciofluvial and glaciomarine ice-contact delta deposits (unit Pmdi)

These deposits consist of ice-contact sand, gravel, silt, and mud that built into the late-glacial sea. They indicate stillstand positions of the ice margin as it retreated northward through the area. The positions are based on topographic expression, including collapsed kettle topography, ice-contact slopes, and topset-foreset bedding where exposed in borrow pits. The deltaic sediments are graded southward or southeastward in each deposit. Two deltas in the map area are given unique names: the younger, Gracelawn delta (Pmdigl) is at the northwest edge of the map; it has a topset-foreset contact measured at 336 feet elevation (Thompson and others, 1989). The older named glaciomarine ice-contact delta is in the central part of the map area and is named herein the Armory delta (Pmdia). Parts of these marine deltas have been eroded by streams during offlap of the sea.

Much of unit Pmdi in the Lewiston area is underlain by silt and clay of probable glaciomarine origin (Presumpscot Formation, unit Pp). For the most part, the underlying silt and clay is not exposed except in stream valleys that have cut down through the overlying sands, or in man-made excavations. The thickness of the delta deposits may be as great as 21 meters (70 feet). Delta deposits are useful as sources of sand and gravel.

In places, unit Pmdi is overlain by dune deposits (Qe), some of which are thin and unmapped.

Glaciomarine bottom deposits (Presumpscot Formation) (unit Pp)

Muddy sediments consisting predominantly of silt and clay with local sandy beds and intercalations are interpreted here as late-glacial sea-floor deposits of the Presumpscot Formation (Bloom, 1960). These deposits were derived from glacial meltwaters and laid down at the bottom of the late-glacial sea following the retreat of the ice sheet and prior to uplift of the area above the sea. The silt and clay commonly lies below about the 310-foot contour—beneath units Ha, Hw, Qst, Pmn, Pa, Pmdi, and Pmrs. Subsuface data and exposures indicate it overlies Pt, bedrock, fans and end moraines and can be interbedded with submarine fan deposits. It is more than 150 ft (50 m) thick in one well in downtown Lewiston, but is generally much thinner throughout the Lewiston area. In the southeast part of the map area, Pp is overlain by relatively thick dune deposits (Qe), but where the Presumpscot Formation lies near the surface, it is generally covered by thin unmapped dune deposits throughout the area.

Marine nearshore deposits (unit Pmn)

This unit consists of waterlaid sediments ranging from clay to gravel that are inferred to have been deposited as a result of wave action in nearshore and shallow marine environments throughout the map area. Some beach deposits can be identified in parts of the areas mapped as this unit. For example, the semi-flat area (290-310 contour intervals) at the base of the slope south of Cottage Road (site of the 3 sets of glacial striations) in the central part of the map appears to be a thin gravel beach deposit. Pmn deposits are thin (commonly less than 10 feet [3 m] thick), generally overlie till or high-level marine bottom deposits, and are found at higher levels than Pmrs deposits; in places, unit Pmn is associated with or overlain by dune deposits (Qe).

Marine regressive deposits (unit Pmrs)

Relatively thin deposits of sand, silt, and minor gravel are interpreted to be reworked marine delta and fan deposits, esker materials, and sea-floor deposits redistributed by marine currents and wave action as sea level fell during late-glacial time, long after the glacier left the immediate area. After deposition of the Presumpscot Formation (unit Pp), existing units were reworked and regressive sandy deposits were laid down (Pmrs). Generally, these are thin and are not more that 10 ft (3 m) thick. They overlie parts of units Pmdi, Pge, and Pp; and, in places, Pmrs is overlain by relatively thick dune deposits (Qe) or thin unmapped dune deposits.

Braided stream alluvium (unit Pa)

During late-glacial time, when the sea had regressed below the surface of the marine bottom deposits (Pp) and marine regressive deposits (Pmrs) in the Lewiston area, the late-glacial Androscoggin River incised a broad channel into those deposits, forming braided stream deposits possibly graded at least in part to the Brunswick sand plain described by Weddle (1997b, p.8). Today, unit Pa consists of a series of high-level terraces along the margins of the Androscoggin River and its major tributaries in the quadrangle. These terraces are easily recognizable from near the northern edge of the quadrangle and southward, but not farther north. More detailed mapping to the north may lead to their identification there as well. In several places, several successively higher terraces can be identified in this unit, but they are lumped together as one unit for simplicity on the map. Waters that incised the channel reworked all glacial deposits that they cut down through, including esker (Pge), till (Pt), marine delta and fan deposits (Pmdi), marine nearshore (Pmn) and regressive deposits (Pmrs), and marine bottom deposits (Pp). Pa deposits may be in part contemporaneous with alluvial fan (Qf) and eolian deposits (Qe).

Alluvial fan deposits (unit Qf)

Small to moderate-sized fan-shaped deposits of variably sorted sand, gravel, and mud were built by ephemeral or small streams, probably during torrential rainfall events, where the streams emerge from steep slopes onto flat plains or into swamps. One such deposit is found where a small stream enters a swamp just south of No Name Pond; and several smaller fans are located along the margin of the braided stream alluvial deposits (Pa) in the Androscoggin valley in the southern part of the map area. The southernmost fan deposit appears to be built out over modern alluvium (Ha). Further detailed research would probably lead to identification of other alluvial fan deposits in the quadrangle.

Eolian deposits (unit Qe)

When sea level fell and exposed the glacial outwash and marine regressive deposits, wind erosion was extensive before vegetation was able to take root and anchor the sediments. As a result, generally thin deposits of windblown sand formed. Only the larger Qe deposits are mapped here. Thin dune deposits are far more extensive than the area mapped as Qe in the Lewiston area, because dune deposits are patchy and not easily recognized except in excavations, which are sparse. Detailed mapping of all these dune deposits in the area may help decipher the complex history of their formation.

Stream terrace (unit Qst)

In cutting down their channels to their present levels, the postglacial and modern Androscoggin River and its tributaries cut into glacial deposits and built or carved stream terraces along their paths, parts of which are preserved as elevated terraces along margins of the modern flood plains. Areas mapped as Qst in the Lewiston area constitute the lowest mappable terrace level in the valley and are interpreted to be very late glacial to postglacial in age. Some of the Qst area may be inundated during major floods (terraces 16-25 feet [5-8 m] above the modern flood plain or river level), but most Qst appears to be high enough to miss being inundated during ordinary flooding. Where the terrace surface is underlain by alluvial material, it may contain as much as 15 ft (5 m) of sand and gravel over the underlying earlier deposits.

Wetland deposits (unit Hw)

Freshwater swamp deposits characterized by accumulations of fine-grained organic-rich sediments deposited in low, flat, poorly drained areas are scattered throughout the quadrangle. Little information is available on the thickness of these deposits in the Lewiston area, though Cameron and others (1984) report that peat deposits in southwestern Maine generally average less than 20 ft (6 m) in thickness. In places the unit is indistinguishable from, grades into, or is interbedded with alluvium (Ha). It should be noted that both swamp (Hw) and alluvial deposits (Ha) are coincident along many stretches of flood plains in this area.

Stream alluvium (unit Ha)

Sand, gravel, silt, and organic material deposited by modern streams on their flood plains is mapped as stream alluvium. The extent of alluvium indicates areas that flooded in the past and may be subject to flooding in the future. In places the unit is indistinguishable from, grades into, or is interbedded with wetland deposits (Hw). Both swamp (Hw) and alluvial deposits (Ha) are coincident along many stretches of flood plains in this area.

Artificial fill (unit af)

Areas where the original ground surface is covered by a substantial thickness of imported material, both man-made and natural, are mapped as artificial fill (unit af). The material varies from natural sand and gravel to quarry waste to sanitary landfill. The thickness varies, but usually doesn't exceed 20 ft (6 m).

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