Stratified Waterlain Glacigenic Sediments and the "New Sharon Soil," New Sharon, Maine

Thomas K. Weddle  
Maine Geological Survey  
State House Station 22  
Augusta, Maine 04333

ABSTRACT

Quaternary deposits exposed in the Sandy River valley at New Sharon, Maine, include stratified waterlain glacigenic sediments which are comprised of interlayered fine-grained sand, silt, clay, and diamicton. At another location, 30 m downstream from this section, is the site of an organic-bearing unit, previously described as a two-till locality.

The glacigenic sediments are interpreted primarily as debris-flow deposits with interbedded basal till, which accumulated in a proglacial lake and were subsequently overridden by advancing Late Wisconsinan ice.

The origin of the organic-bearing unit is unclear. However, while excavation of the unit did not reveal a two-till stratigraphy, it did expose glacigenic sediments similar to the section upstream, overlying organic-bearing silt and peaty, sandy gravel. Previous interpretations of the New Sharon stratigraphy and their regional significance based on the "New Sharon soil" warrant re-evaluation.

INTRODUCTION

The Sandy River valley at New Sharon, west-central Maine, contains some of the best exposures of Quaternary deposits in New England. It is also the site of the only surface locality on the New England mainland where organic material is reported to occur between older- and younger-aged tills (Caldwell, 1959, 1960; Schafer and Hartshorn, 1965; Mickelson et al., 1983; Stone and Borns, 1986; Borns et al., 1987). The stratigraphy is considered by many workers to be critical to understanding the glacial history of New England, in particular the number of regional ice advances which have occurred in the area.

There are several exposures of glacigenic sediments along the Sandy River from New Sharon downstream to Mercer. At one of these exposures (Site A, Fig. 1), there is a section of stratified waterlain glacigenic sediments comprised of thinly-bedded silt, fine-grained sand, clay, and diamicton, as well as thickly-bedded diamicton. Approximately 30 m downstream from Site A is another section which contains an organic-bearing unit, but is presently covered by stream alluvium (Site B, Fig. 1, this paper; locality C of Caldwell, 1959).

The organic-bearing unit at New Sharon has been described by others as a brown silt and a buried soil (Caldwell, 1959, 1960), buried non-glacial sediments (Borns and Calkin, 1977), a subaerial weathering profile containing organic debris (Mickelson et al., 1983), a nonglacial soil (Oldale and Eskenasy, 1983), the New Sharon soil (Hanson, 1984), an organic silt layer (Koteff and Pessl, 1985), and a paleosol (Stone and Borns, 1986). Some of these workers, as well as others, have suggested regional correlation of till stratigraphy from southern New England to southeastern Quebec, and have based part of their correlation on the New Sharon stratigraphy (Borns and Calkin, 1977; Oldale and Eskenasy, 1983; Hanson, 1984; Koteff and Pessl, 1985; Thompson and Borns, 1985a; Stone and Borns, 1986; Dredge and Thorleifson, 1987; Vincent and Prest, 1987).

Although regional correlations are not presented in this paper, the earlier interpretations of the New Sharon stratigraphy are being re-evaluated (Weddle, in prep.). The purpose of this paper is to discuss the origin of the glacigenic sediments at Site A and their relation to the organic-bearing unit at Site B (Fig. 1).
Figure 1. Study site. (A) indicates location of stratified waterlain glacigenic sediments. (B) indicates location of organic-bearing unit (from New Sharon 7.5 minute USGS topographic map).

PREVIOUS WORK

Caldwell (1959) was the first to refer specifically to the sections along the Sandy River at New Sharon. However, Clapp (1906, 1908) referred to an old till exposed at Norridgewock, a town approximately 8 km northeast of New Sharon. Unfortunately, the location was not accurately described, and could not be found by the author. The Norridgewock site was mentioned by Leavitt and Perkins (1935), but was not exposed at the time of their study. However, the section at New Sharon was reportedly known by Dr. E. H. Perkins to contain organic macrofossils (H. W. Borns, Jr., pers. commun., 1986), though it is not mentioned in Leavitt and Perkins (1935). Dr. Joseph M. Trefethen, Maine State Geologist Emeritus, was a field assistant to Perkins on the survey for the Leavitt and Perkins (1935) volume, and recalls Perkins' mention of New Sharon as an organic-bearing site (J. M. Trefethen, pers. commun., 1987).

Caldwell (1959, 1960) presented the earliest comprehensive work on the sections at New Sharon. Locality C of Caldwell (1959), from which wood was collected and radiocarbon dated at >38,000 yr B.P. (Y-689, Caldwell, 1960; W-910, Schafer and Hartshorn, 1965), is described from top to bottom as follows: 0.75 m of blue-gray till, over 0.1 m of gray varved clay, over 0.15 - 1.0 m of brown, sandy organic-bearing silt, over 0.25 - 0.8 m of green-gray silt with its upper surface oxidized 0.15 - 0.3 m deep, over 0.3 m of green-gray till. Caldwell (1959) suggested that the varved clay was deposited in a proglacial lake, which existed at the margin of the Late Wisconsinan ice sheet during its advancing phase, and was subsequently overridden by that ice. Caldwell (1960) tentatively assigned a Late Wisconsinan age to the upper till unit, and an Early(? Wisconsinan age to the lower till unit. Later, Caldwell and Pratt (1983), and Caldwell and Weddle (1983) suggested that Middle Wisconsinan aged till may also be present at New Sharon.

Borns and Calkin (1977) drilled a continuous core (Fig. 1) through glacigenic sediment at New Sharon, recording multiple-till layers; however, the boring did not penetrate the organic-bearing sediment. They also submitted wood for radiocarbon dating that yielded an age >52,000 yr B.P. (Y-2683), and suggested two alternative explanations for the multiple-till stratigraphy. The units could represent local, ice-marginal fluctuations, or they could be of regional stratigraphic importance, representing successive, major ice advances across Maine.
The latter interpretation is favored by Borns and Calkin (1977), and they tentatively assigned Early, Middle, and Late Wisconsinan ages to units at New Sharon, correlative with the Quaternary stratigraphy of southeastern Quebec described by MacDonald and Shilts (1971). This stratigraphy and correlation is also proposed by Stone and Borns (1986) to account for the New Sharon section in the regional Pleistocene stratigraphy of New England.

However, Thompson and Borns (1985a) suggest that much of the section at New Sharon could be pre-Late Wisconsinan in age, and Borns et al. (1987) describe the section at New Sharon as consisting of a Late Wisconsinan till overlying an organic silt, in turn underlain by two till units. This latter stratigraphic description is not consistent with the earlier assignments by Stone and Borns (1986) and by Borns and Calkin (1977) of two regionally significant tills, described from the test boring, which presumably overlie the organic-bearing unit and the lower till described by Caldwell (1959).

SITE A

Facies Description

The section exposing the glacialic sediments (Site A on Fig. 1) occurs along the north bank of the Sandy River (Fig. 2) and is approximately 4 m thick. A schematic stratigraphic section of the exposure showing facies is represented in Figure 3. The sequence is characterized by two general facies recognized at the site; diamictons and fine-grained units (Fig. 3, Table 1).

Diamictons

The diamictons (Figs. 3, 4, Table 1) vary in grain size from clay-sized particles to clasts mostly 1 - 3 cm in length, with some boulders greater than 0.5 m in length. Most clasts are subrounded to subangular, and many are striated. The color of the diamictons is uniformly olive-gray (Munsell color 5Y 5/2). Metasiltstone and metasandstone are the dominant clast lithologies, with less common granite, granite-gneiss, gabbro, metavolcanic, quartz, and metaconglomerate clasts also present.

The diamictons generally are matrix supported, with crude stratification in most units. Normal grading is also present, and stringers of fine-grained sand are found in places. Thickness of the diamicton layers varies from a few cm to about 1 m. The contacts between beds are generally sharp and conformable, although rare erosional contacts can be found.

Pebble orientations were measured from discrete diamicton layers, and their fabrics were plotted (Fig. 5). Clasts with long to intermediate axial ratios of at least 3:2 were measured, and the trend and plunge of the long axis was recorded, plotted on an equal-area net (lower hemisphere projection), and contoured using a computer program written by C. E. Corbato (Ohio State University) as modified by D. E. Lawson (Cold Regions Research and Engineering Laboratory). Petrofabric orientations were evaluated statistically using the eigenvalue method of Mark (1973, 1974) as modified by D. E. Lawson. In this method, the significance value (S1) of the fabric represents the strength of clustering about a mean axis, where a value of 1.00 is uniform and 0.00 is random.

Figures 5a and 5b (Site A on Fig. 1; Fig. 3) have preferred orientations along a northwest-southeast trend, but 5a is polymodally distributed, with weaker orientations along east-northeast - west-southwest trends. The S1 values for 5a and 5b are 0.60 and 0.70, respectively. Fabric 5c, from the lowest unit exposed at Site A, has a strong preferred NW-SE trend. Clast

<table>
<thead>
<tr>
<th>CODE</th>
<th>FACIES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dmm</td>
<td>Matrix-supported, massive diamicton.</td>
<td>Structureless mud, sand, pebble admixture.</td>
</tr>
<tr>
<td>Dms</td>
<td>Matrix-supported, stratified diamicton.</td>
<td>Obvious textural segregation or sorting within unit. Stratification more than 10% of unit thickness.</td>
</tr>
<tr>
<td>Dms(r)</td>
<td>Dms with evidence of resedimentation.</td>
<td>Flow noses present; diamicton contains deformed silt/clay laminae and stringers, and rip-up clasts. Grading present; clast fabric random or parallel to bedding. Erosion and incorporation of underlying units.</td>
</tr>
<tr>
<td>Dmg</td>
<td>Matrix-supported, graded diamicton.</td>
<td>Unit exhibits vertical grading in matrix or clast content.</td>
</tr>
<tr>
<td>Fld</td>
<td>Fine-grained, laminated unit.</td>
<td>Laminated silt and clay with dropstones.</td>
</tr>
<tr>
<td>Fmd</td>
<td>Fine-grained, massive unit.</td>
<td>Massive silt and clay with dropstones.</td>
</tr>
</tbody>
</table>
Figure 3. Schematic stratigraphic section of sediments exposed at New Sharon (Site A).

Figure 4. Features related to sediment flow and subaqueous deposition at New Sharon. (a) Flow nose in fine-grained deposits.
Figure 4 (continued). Features related to sediment flow and subaqueous deposition at New Sharon. (b) Nonstriated outsized clast (dropstone?) in fine-grained deposits. (c) Monolithologic, subangular rip-up clasts of fine-grained unit in diamicton. (d) Erosional contact between fine-grained unit (below) and diamicton unit (above). (e) Dropped silt clasts in fine-grained units. (f) Conformable contact between fine-grained unit (below) and diamicton unit (above). (g) Graded beds in fine-grained unit.
Figure 5. Petrofabrics of diamictons from Site A at New Sharon (5a-c); fabrics 5d and 5e are from similar units on opposite bank of river from Site A. $S_1$ = significance of fabric strength; $V_1$ = trend and plunge of azimuthal vector; $n$ = number of measurements. Contour interval = 2 sigma.
axial trends cluster in a tight grouping with a preferential NW plunge, and the fabric has an $S_1$ value of 0.94.

Facies 5d and 5e are from stratified diamictons which occur on the opposite bank from site A. These fabrics are also polymodally distributed, with NE-SW trends, and the fabrics of clasts in 5d and 5e have a preferential NE plunge. The $S_1$ values for 5d and 5e are 0.78 and 0.57, respectively.

**Fine-Grained Facies**

The fine-grained facies (Figs. 3, 4, Table 1) consist of laminated clay, silt, and fine-grained sand, as well as more massive silt and clay layers, up to 3 cm thick. The colors of the units in this facies vary from gray to dark gray (5Y 5/1 and 5Y 4/1). There is no noticeable gradational color change between or within the fine-grained units or the stratified diamicton units. Diamicton layers less than 1 cm thick are commonly interbedded with the fine-grained units. Thin beds and laminae of diamicton often occur as the basal portion of thinly-bedded, fining-upward rhythmic sequences of diamicton, fine-grained sand, silt, and clay. Outsized clasts, and non-lithified clasts of silt and fine-grained sand (0.1 - 0.5 cm) also occur in this facies.

The rhythmic nature of the sediments at site A has been noted by other workers (Caldwell, 1959), and the sediments have been described as varves. The repetition of diamicton, silt, and clay in these sediments suggests some cyclic deposition of these units. An embedded Markov chain analysis was performed, testing for randomness in the sequence of sediments, utilizing the quasi-independence model of Powers and Easterling (1982). A chi-square ($X^2$) test of significance of the quasi-independence transitional frequency of facies results in $X^2$ of 18.09. With 19 degrees of freedom, the probability of any significant periodicity in the sequence is less than 50% (Table 2).

Harms et al. (1982) believe that analyzing for Markovian processes works best in systems which have several facies and many repeated sequences. Due to the small exposure of this section and lack of many repetitive sequences, the use of this test may not be applicable to the units described here.

**Interpretation**

The sediments exposed at this section at New Sharon are interpreted primarily as the products of sediment-flow deposition in a subaqueous environment, and to a lesser degree by basal processes. The fine-grained units are interpreted as the result of sediment flows (debris flows, turbidity flows), and rain-out following a sediment flow. Ashley et al. (1985) have distinguished between slump-generated surge rhythms and annual rhythms. Following their criteria to distinguish between annual- and surge-rhythmites, the fine-grained sediments at New Sharon are graded, they do not occur as discrete clay and silt beds forming couplets (unlike varves), and the clay beds in the rhythms are not of consistent thickness. These qualities in context with the Markov chain analysis suggest the rhythmic nature of the sediments results from randomly occurring events, and that the sediments are not annual deposits.

Horizontal layering of several meters in lateral extent, outsized clasts within the fine-grained units, draped beds over the upper surface of some interbedded thick diamicton units, normally-graded thin beds of medium- to fine-grained sand, and very rare isolated cross-bedding in fine-grained sand layers within the unit suggest a subaqueous depositional environment for the fine-grained facies.

Stratigraphic sequences found along Lake Erie, Ontario, similar in description to the New Sharon deposits, have been interpreted as the result of basal melt-out beneath the floating terminus of the ice sheet (Driemanis, 1979, 1982; Gibbard, 1980), and by other complex processes (Driemanis et al., 1987). Ashley et al. (1985) also have described how stratified sediments can form subglacially by basal melt-out processes. Several interpretations have been proposed for interbedded diamictons and rhythmic sediments near Toronto, Ontario (Eyles and Eyles, 1983; Sharpe and Barnett, 1985; Sharpe, 1987, 1988a,b). Other workers have presented studies on how different glacial deposits can be characterized according to properties developed during their deposition, enabling the worker to distinguish between different modes of deposition associated with glaciation (for example, Shaw, 1977, 1982, 1983; Boulton, 1979; Lawson, 1979a,b, 1981a,b, 1982; Boulton and DeNoyaux, 1981; Haldorsen and Shaw, 1982; Eyles et al., 1983; Eyles and Miall, 1984; Gravenor et al., 1984; Ashley et al., 1985; Goldthwait and Matsch, 1988). A common theme in the papers cited focuses on the complex nature of the glacial environment, and that specific distinguishing criteria must be evaluated with the general characteristics of the sediments before interpretations of origins of glacial deposits can be made. Studies by Boulton (1971), Mills (1977; 1984), Lawson (1981a,b), Haldorsen and Shaw (1982), Shaw (1982), and Gravenor et al. (1984) are relevant to the glaciogenic sediments at New Sharon. These authors point out that pebble fabrics in lodgement or melt-out tills may have a preferential alignment and may show an imbrication that dips up-glacier. Melt-out till may show transverse clast orientation and the up-glacier dip of clasts may not be as steep as in lodgement till. Clast fabrics in sediment-flow deposits generally

**TABLE 2. EMBEDDED MARKOV CHAIN ANALYSIS.**

<table>
<thead>
<tr>
<th>Facies</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dmm</td>
<td>---</td>
<td>.45</td>
<td>.13</td>
<td>.70</td>
<td>.28</td>
<td>.45</td>
<td>.95</td>
</tr>
<tr>
<td>Dms</td>
<td>.45</td>
<td>---</td>
<td>.21</td>
<td>1.14</td>
<td>.45</td>
<td>.73</td>
<td>2.98</td>
</tr>
<tr>
<td>Dms(t)</td>
<td>.12</td>
<td>.21</td>
<td>---</td>
<td>.32</td>
<td>.13</td>
<td>.21</td>
<td>0.99</td>
</tr>
<tr>
<td>Dmg</td>
<td>.69</td>
<td>1.13</td>
<td>.31</td>
<td>---</td>
<td>.69</td>
<td>1.13</td>
<td>3.95</td>
</tr>
<tr>
<td>Fmd</td>
<td>.28</td>
<td>.45</td>
<td>.13</td>
<td>.70</td>
<td>---</td>
<td>.45</td>
<td>1.59</td>
</tr>
<tr>
<td>Fild</td>
<td>.45</td>
<td>.73</td>
<td>.21</td>
<td>1.13</td>
<td>.45</td>
<td>---</td>
<td>2.97</td>
</tr>
<tr>
<td>Σ</td>
<td>1.99</td>
<td>2.97</td>
<td>0.99</td>
<td>3.99</td>
<td>1.58</td>
<td>2.97</td>
<td>9.09</td>
</tr>
</tbody>
</table>

degrees of freedom = 20

$X^2 = 18.09$

$P > 0.5$
show a poorly-defined preferred orientation, or none at all. Pebbles in flows may show a polymodal distribution, and principal-axis orientations could lie either parallel or transverse to the direction of sediment flows.

Furthermore, Lawson (1979b) has shown from studies at the Matanuska Glacier in Alaska that the strength of clustering about the mean axis of pebble orientations varies considerably between melt-out till and sediment flows. The $S_1$ values from clasts in basal zone ice range from 0.77 to 0.99, with a mean of 0.86. For melt-out till, $S_1$ values range from 0.75 to 0.89, with a mean of 0.82, and for sediment-flow and ice-slope colluvium deposits, values range from 0.49 to 0.70, with a mean of 0.57. The close values for the strength of basal zone ice and melt-out till fabrics suggests that melt-out till fabric is generally preserved during the melt-out process.

For Pleistocene till in Edmonton, Canada, Shaw (1982) shows that the primary clast fabric for relatively undisturbed melt-out till is largely preserved. While the grand distribution of the samples has a fabric strength of 0.81, the mean is 0.61 and individual distributions show preferred orientations at variance from ice-flow direction. Samples from within the main body of the unit which retained preferred orientations parallel to ice-flow direction show strength values ranging from 0.54 to 0.84, with a mean of 0.69. Samples from locations adjacent to or in disturbed or reworked zones show orientations inconsistent with ice-flow direction, with strength values ranging from 0.46 to 0.63, and a mean of 0.55. Also, Balderson and Shaw (1982) show that for Pleistocene till in Aastalen, Norway, melt-out or flow till $S_1$ values range from 0.53 to 0.66, with a mean of 0.58. For the Norwegian tills, the orientation of the fabrics from melt-out till shows preferred alignment parallel to last ice movement, whereas deposits of equivocal melt-out or flow till origin show preferred orientation oblique to regional ice movement.

Eyles et al. (1988) have discussed Late Pleistocene subaerial debris-flow deposits near Banff, Canada, which show shallow imbrication either up- or down-flow direction, and fabrics both transverse and parallel to flow direction. The strength of these fabrics range from 0.47 to 0.91, with a mean of 0.64. For a glaciogenic diamicton sequence in British Columbia, Parker and Hicock (1988) have presented a range of fabric strengths from lodgement till (0.47 - 0.66, mean 0.57) and from glaciogenic and subaquatic flow (0.43 - 0.73, mean 0.52). Montane glacial diamictons from Alberta have been studied by Leveson and Rutter (1988) and have been subdivided into several categories. The strength of the fabrics of some of these units has been determined; for basal till (lodgement and melt-out) the range is 0.64 - 0.78, mean 0.69, for englacial melt-out till the range is 0.50 - 0.57, mean 0.53, and for subaerial flow till the range is 0.47 - 0.50, mean 0.48.

Studies of glacial deposits in northeastern Illinois by Johnson et al. (1985), Hansel et al. (1987), and Hansel and Johnson (1987) provide information on fabric strength of late Wisconsinan till in that region. Fabrics from diamictons described as subglacial till range from 0.55 to 0.95, with a mean of 0.77. Of interest, however, is the slight difference in fabric strength of units interpreted as lodgement till compared to basal melt-out till. In these units, fabric strength of lodgement till varies from 0.65 to 0.94 (mean 0.80), whereas basal melt-out till varies from 0.55 to 0.95 (mean 0.81). Johnson et al. (1985) caution that a single criterion cannot be used to differentiate diamicton resulting from lodgement, melt-out, or sediment flow.

Dowdeswell et al. (1985) in comparing clast fabrics of ancient and modern glacial deposits suggest that lodgement till fabric is less strong than basal melt-out till fabric. These data from lodgement till at the front of Icelandic glaciers have a mean fabric strength of 0.69. However, Boulton and Deynoux (1981) and Mills (1984) suggest that scatter in basal tills is a sign of post-depositional deformation. Dowdeswell and Sharp (1986) indicate that fabric data from modern glacial sedimentary environments can be useful in interpreting the depositional environment of Quaternary glacial deposits. They note that there is a general reduction in fabric strength and increase in clast dip associated with the transition from melt-out tills, through undeformed and deformed lodgement tills, to sediment flows. Rappol (1985), however, suggests that clast fabrics from Pleistocene sediments in Allgau, Germany, do not clearly distinguish between subglacial till and debris flow deposits. Finally, May et al. (1980) have reviewed the need for caution in the interpretation of till fabrics, and according to Dowdeswell et al. (1985), if field related criteria are not considered, fabric analyses have limitations due to ambiguity of interpretation.

The diamicton prot.efabrics from Site A, in general, are interpreted as orientations unrelated to basal deposition. Three fabrics from the glaciogenic sediments (Figs. 5a, 5d, and 5e) have orientations transverse to the last regional ice-flow direction, which is indicated by NW-SE trending striations and streamlined forms in the study area (Caldwell, 1959, 1966; Thompson and Borns, 1985; Weddle, 1987). One fabric (Fig. 5b) crudely trends along the regional ice-flow direction, but the contour pattern lacks a strong single maximum and clast plunge is preferentially down-ice, contrary to what might be expected for a lodgement or basal melt-out till. Fabric 5d has a moderately strong fabric with moderate clast scatter, but is oriented transverse to ice-flow direction. This orientation could be a result of compressive flow. Alternatively, the transverse fabrics could represent debris flow material deposited into the lake by fans along the valley sides. The $S_1$ values of these fabrics (5a,b,d,e) are less than uniformity and vary from 0.57 to 0.78, with a mean value of 0.66, somewhat lower than the means of basal tills presented earlier. While these values are within the lower range of basal till, in particular fabrics 5b and 5d, and may represent post-depositional deformation of basal till, the diamictons must be evaluated within the sedimentary and stratigraphic context in which they occur, and these considerations suggest that fabrics 5a and 5e are not reflective of lodgement or basal melt-out processes. While fabrics 5b and 5d are more representative of subglacial processes, their stratigraphic positions suggest alternative modes of origin to basal deposition.
However, the diamicton at the base of the section at Site A (Fig. 5c) has a fabric that reflects basal processes. The lower contact of this unit is not exposed and those contact relations are not known, but the unit contains striated, bullet-shaped clasts, the axes of which have NW-dipping imbrication, and plot as a single maximum with a measure of fabric strength at 0.94.

The general dominance of polymodal orientation and moderate to large scatter rather than a single maximum of the long axes of clasts in diamictons, occurrence of outsized clasts and draping of layers over the clasts, generally sharp and conformable contacts between units, flow folds and drag folds, rip-up clasts, graded beds, and silt and sand clots in laminated beds suggest the sediments at Site A are primarily the result of subaqueous deposition into a proglacial lake, interrupted occasionally by ice marginal fluctuations when basal till was deposited. An environment similar to the model proposed by Evenson et al. (1977) for the lower Catfish Creek till at Plum Point, Ontario, is envisioned as the environment of deposition of the glacigenic sediments at Site A at New Sharon.

SITE B

Organic-Bearing Unit (New Sharon Beds)

The organic-bearing unit is located at site B, approximately 30 m downstream from site A (Fig. 1). This unit is now covered by stream alluvium, but was re-excavated in 1985 to examine the relation between it and the glacigenic sediments it was reported to be associated with (Caldwell, 1959; Weddle, 1986). This excavation provided almost 3 m of vertical exposure and the stratigraphy varied from that originally described by Caldwell (1959).

The trench exposed 0.5 m of gray, layered sediment, similar to the sediments at site A, sharply overlying 1 m of intensely deformed organic-bearing silt (containing wood fragments) and interbedded silty pebbly sand, which abruptly overlies 1.5 m of massive sandy gravel (Fig. 6). The gravel, which contains fragments of peat, is cut by a 3-cm wide, subvertical, gray (2.5Y 5/0) west-dipping diamicton stringer. It has been proposed that the organic-bearing silt and the gravel be referred to informally as the New Sharon Beds (Weddle, 1988).

The sandy gravel immediately below the silt is unoxidized, but approximately 1 m below this contact the color of the gravel changes abruptly but gradationally downward from gray (2.5YR 6/0) to reddish yellow (5YR 6/8 - 7.5YR 6/8). The organic-bearing silt does not display any gradational color change from its surface downward, nor is there any obvious weathering or soil profile developed on its surface. The silt is comprised of thinly laminated, alternating layers of very dark to dark grayish brown (2.5Y 3/2 - 4/2), and dark gray to olive gray (5Y 4/1 - 4/2) fine sandy silt and silty fine sand. The silt layers are complexly deformed (Fig. 7); in places they are cut by east-over-west thrusts. However, the deformation in the New Sharon Beds does not extend upward into the overlying gray layered sediments.

Figure 6. (a) Schematic diagram of the New Sharon Beds, excavated 24 July 1985, at New Sharon, Maine (Site B on Fig. 1).
Figure 6 (continued). (b) Photograph of excavation (north face), entrenching tool approximately 0.5 m in length.

Figure 7. Close-up of deformed sand layers in the New Sharon Beds at New Sharon, Maine (north face).

Other than as the thin stringer which cuts the gravel of the New Sharon Beds, diamicton was not encountered in the excavation. However, trenching had to be ceased at 3 m depth due to ground water seepage into the pit. Single-channel seismic refraction lines run parallel to the trench indicate velocities of 1800-2250 m/s at depths greater than 3 m, which suggests that a very compact non-lithified unit underlies the gravel. Bedrock velocities (greater than 4500 m/s) occur at a depth of approximately 24 m (Weddle and Caldwell, 1986; Weddle, 1986).

Eight samples were collected from the silty unit, four from gray, and four from grayish-brown layers. These were analyzed by X-ray diffraction (XRD) for clay-mineral identification and evidence of alteration following the methods described by Jackson (1956) and Carroll (1970). Samples were treated with hydrogen peroxide to eliminate organic material. Oriented mounts of the less than 1 micron fraction of the clay percentage of the samples were prepared by centrifuging the clay fraction, mounting the material on a glass slide by vacuum suction, and allowing the slide to air dry. Slides were scanned on a Philips x-ray diffractometer, from 32 to 2 degrees 2 theta at 2°/min, at optimum MA, KV, and range. Samples were run air-dried, treated with ethylene glycol, K-saturated, and heated to test for mineral alteration.

Two sample analyses are shown in Figure 8, one from each color variation of the silt. Fe-chlorite reflections are represented by the 14, 7, 4.7, and 3.5 angstrom peaks; illite/mica reflections are represented by the 10, 5, and 3.3 angstrom peaks. The failure of any noticeable expansion of the 14 angstrom peak after ethylene glycolation, or any significant collapse of peaks after K-saturation or low heat treatment in any of the eight samples indicates that altered chlorite and illite are not present in the samples.

Identification of pollen grains and macrofossil fragments from the New Sharon Beds was done by Dr. Robert Nelson, Colby College. The silt contained wood fragments and abundant alder, pine, and spruce pollen, and very little hardwood pollen (R. Nelson, pers. commun., 1985). The analyses are consistent with earlier analyses indicating a climate cooler than present, more representative of an interstadiul deposit than an interglacial deposit, although probably harsher conditions than the closed spruce-pine forest indicated by the earlier pollen analyses (Caldwell, 1960; Caldwell and Weddle, 1983; Appendix A, this report).

During the fall of 1987, the Water Resources Division of the U.S. Geological Survey office in Augusta drilled a test boring at New Sharon as part of its statewide ground water monitoring program. The boring location is shown on Figure 1. Surface elevation at the test boring site is approximately 94 m above sea level, and the surface elevation of the New Sharon Beds (Site B) is approximately 89 m above sea level. The boring penetrated almost 12 m of glacigenic sediments similar in appearance to the deposits at Site A. The drilling was conducted using a hollow-stem auger, and samples were collected by split-spoon sampling; the complete log of the boring is given in Appendix B. The boring did not penetrate the New Sharon Beds, but at the depth equivalent to their surface elevation, glacigenic material similar to that at Site A was recovered. The boring was terminated when a boulder was encountered which could not be penetrated. The seismic data previously mentioned confirms that boring refusal was not at bedrock, but rather at a boulder.

DISCUSSION

The numerous references by others (Caldwell, 1959, 1960; Borns and Calkin, 1977; Mickelson et al., 1983; Oldale and Eskenasy, 1983; Hanson, 1984; Koteff and Pessl, 1985; Stone and Borns, 1986) to the weathered appearance of the New Sharon Beds is not substantiated by the 1985 excavation and subsequent XRD analyses. This is significant because some of these workers proposed regional correlations based in part upon the reported presence of a buried soil at New Sharon. No visible
soil profile or surface weathering horizon is present in the silt or the gravel, although the gravel has an oxidized appearance with depth, intensifying downward.

Koteff and Pessl (1985) describe a two-till section at Nash Stream, New Hampshire, comprised of upper and lower till units, separated by stratified drift. In places, the lower till at Nash Stream is overlain by lacustrine sediments, and the lacustrine sediments vary in color from pale yellow to very pale brown, with a pinkish cast. This suggests that some degree of oxidation of the lacustrine sediments may have occurred. Where the lower till is exposed at the surface, it is deeply oxidized. This oxidation of the lower till and lacustrine sediments is interpreted to be a function of a lengthy interglacial or interstadial weathering interval (Koteff and Pessl, 1985). The Nash Stream section is regarded by Koteff and Pessl (1985) as an appropriate reference section for the two-till stratigraphy of southern New England.

In southern New England, two-tills, an upper and lower till, have long been differentiated by several characteristics (Schafer and Hartshorn, 1965; Pessl and Schafer, 1968; Koteff and Pessl, 1985). One of these characteristics is the presence of an oxidized zone in the lower till which decreases in intensity with depth from the surface. Newton (1978, 1979) described the mineralogical characteristics of the oxidized zone of the lower till, and interpreted it as a paleosol, based primarily on differences in weathering of clay minerals from the upper till and the lower till. He also found that the clay minerals in the weathering profile are characterized by the alteration of chlorite and illite to vermiculite and mixed-layer illite-vermiculite.

Newman et al. (1987) conducted similar clay-mineral studies on tills from drumlins in Boston Harbor, Boston, Massachusetts. They described two distinct tills, upper and lower units, distinguished along with other criteria by a weathering horizon in the lower till, and degree of alteration of chlorite to vermiculite in the horizon. They interpreted the alteration to be due to soil development, and the more intensely weathered lower till to be of greater age than the less intensely weathered upper till.

The gravel unit from the New Sharon Beds may be outwash associated with an earlier glaciation, or an interstadial stream gravel. However, the oxidation associated with the gravel at New Sharon is unlike the oxidation of the lacustrine deposits or lower till at Nash Stream, or the oxidized zone on the lower till.
of southern New England. Whereas the oxidation intensity decreases with depth in the lower till of southern New England, the oxidation intensity increases with depth in the gravel of the New Sharon Beds.

Assigning an age to the oxidation of the gravel, or suggesting an interglacial or interstadial weathering interval to account for the oxidation is unjustified because no studies have been done to evaluate the oxidation of the gravel from New Sharon. Furthermore, the XRD analyses of the silts from the New Sharon Beds indicate that there has been no soil development associated with that unit. In particular, chlorite and illite alteration to vermiculite and mixed-layer illite/vermiculite as noted by Newton (1978, 1979) in the southern New England lower till is lacking in the New Sharon Beds. The New Sharon Beds contain no record of ever being subjected to weathering comparable to that proposed for the lower till of southern New England.

CONCLUSION

The stratified waterlain glacigenic sediments at New Sharon are interpreted as the product of sedimentation into a proglacial lake. From New Sharon to its junction with the Kennebec River, the Sandy River is a northeastward-flowing tributary. If proglacial drainage in the Sandy River valley was similar to present-day drainage, southward advancing ice in the Kennebec River valley could have blocked drainage of the northeastward-flowing tributary, creating an ice-dammed proglacial lake in the Sandy River valley.

The glacigenic sediments at Sites A and B represent part of a sequence of proglacial materials of lacustrine and subglacial origin, deposited as debris flows and turbidity flows, and to a lesser extent by basal processes. The lack of significant weathering horizons or significant breaks in deposition between any of the units suggests the deposits are the product of a single glacial event, most likely of early Late Wisconsinan age, and constitute part of the regional Late Wisconsinan surface drift of the area. Initial observations by Caldwell (1959), and more recent studies (Caldwell and Weddle, 1983; Weddle, 1985, 1986; Weddle and Caldwell, 1984, 1986; Weddle and Retelle, 1988), indicate these glacigenic sediments were subsequently overridden by the main phase of Late Wisconsinan ice.

The relation between the New Sharon Beds and the glacigenic sediments is not completely clear. Glacigenic sediments occur stratigraphically above the New Sharon Beds. pollen from the New Sharon Beds contains specimens from aquatic plants (Caldwell and Weddle, 1983; R. Nelson, pers. commun., 1985), and the thinly bedded deformed silt layers of that unit may be lacustrine. Alternatively, although a thorough facies analysis was not conducted on the New Sharon Beds, the stratigraphy exposed in the trench may represent glacial outwash or stream alluvium with overlying flood-plain deposits.

A further complication is that the New Sharon Beds appear to be more complexly deformed than the overlying glacigenic sediments. This deformation could be accounted for by emplacing the New Sharon Beds in the stratigraphy by ice shove (glacial rafting), possibly in a manner similar to that described by Ruszczyńska-Szenajch (1987), who has subdivided glacial rafts into three genetic groups. These include (1) glaciotectonic rafts that have been detached and transported by mechanical action of the glacier, without being incorporated within the ice body; these may be subdivided into (a) squeezed-out or pressed-out rafts, (b) dragged rafts, and (c) pushed rafts; (2) glacioerrosional, or glacio-dynamic rafts, that have been detached by freezing onto a glacier and then transported within the ice body; and (3) rafts of composite origin formed by these processes. Without detailed study of the New Sharon Beds, glaciotectonic origin cannot be determined with precision, but must be considered.

The east-over-west thrusts in the New Sharon Beds are not in accord with regional Late Wisconsinan ice-flow indicators shown by Caldwell (1959, 1986), Thompson and Borns (1985b), and Weddle (1987). However, they may be attributed to early Late Wisconsinan ice initially controlled by topography during ice advance, and deforming proglacial deposits as it advanced. Deformation of proglacial deposits has been described by Kalin (1971), Gripp (1979), Rabassa et al. (1979), Humlum (1985), Kruger (1985), Van Der Meer et al. (1985), Boulton (1986), Drozdowski (1987), Eybergen (1987), Van Der Wateren (1987), Van Gijssel (1987), and Croo (1988) in discussing the formation of ice-push moraines in modern and ancient deposits, and by Smith (1988) on the effects of a rapidly advancing glacier on sedimentation in a proglacial lake. Sharp (1985) mentions glaciotectonically deformed sediments in Iceland in which a thrust found in the core of a push-moraine originates at the contact between cohesive silt and peat and underlying sand and gravel. A more detailed discussion of glaciotectonic features and structural geology of the New Sharon sections can be found elsewhere (Weddle, in prep.).

The lack of similar organic-bearing material at any of the other sections along the Sandy River and the deformation associated with the New Sharon Beds suggests that their presence at Site B may be a local phenomenon and that they are allochthonous. It may be that the lowest diamicton at Site A is correlative with the the diamicton under the New Sharon Beds reported by Caldwell (1959). However, he described a weathered appearance to the surface of that unit, and there is no indication of weathering on the surface of the lowest diamicton at Site A. Furthermore, the petrofabric of the lowest unit at Site A corresponds to the regional trend of the Late Wisconsinan ice. Caldwell (1959), however, did note the presence of lineations on the bedding surface of fine-grained deposits above the New Sharon Beds but at the base of the overlying till. He attributed the lineations to overriding ice because they are approximately parallel with regional striations. The New Sharon Beds could then represent a transported block of older material within a sequence of stacked Late Wisconsinan deposits.

This Late Wisconsinan age assignment to the sequence of exposed deposits at New Sharon is contrary to the Quaternary
stratigraphy for Maine as suggested by Borns and Calkin (1977), and Stone and Borns (1986). In particular, there is no direct evidence for Early or Middle Wisconsinan drift deposits at New Sharon as described by Borns and Calkin (1977), and by Stone and Borns (1986), and as alluded to by Caldwell and Pratt (1983), Caldwell and Weddle (1983), Weddle (1985), and Thompson and Borns (1985a).

Thompson and Borns (1985a) suggest that the wood found at New Sharon was killed by ice, and that this constrains the age of the overlying sediments to the age of the wood. The author has not found wood in growth position, nor was the wood found by Caldwell (1959), or Borns and Calkin (1977), reported to be in growth position. However, only material found in growth position should be considered to date the enclosing sediment (Vogel, 1980). If it is not collected in growth position, its age should never be equated with the enclosing sediment (LaSalle and David, 1988). The wood in the New Sharon Beds is not in growth position, and it is likely that the New Sharon Beds are allochthonous.

Finally, it appears that there is a subsurface stratigraphy at New Sharon of at least 24 m thickness. Knowing the stratigraphy beneath the New Sharon Beds only by its seismic velocity is not particularly useful. However, the U.S. Geological Survey test boring showed that the stratigraphy at Site A extends to a depth of at least 6 m below the surface exposure of the New Sharon Beds. These units are clearly derived from a single glacial event, one in which the New Sharon Beds may have been incorporated by glacial rafting during the advancing phase of the Late Wisconsinan ice.

Determining the subsurface stratigraphy through more detailed test borings might resolve whether the New Sharon Beds are truly an allochthonous or autochthonous deposit. The occurrence and lithology of any older, underlying units could also be determined. Re-evaluation of the earlier interpretations of the stratigraphy is warranted. No older, underlying till is currently exposed at New Sharon, although it may occur in the subsurface. The eroded bluffs of glaciolacustrine sediments and diamicton expose deposits of Late Wisconsinan age.

ACKNOWLEDGMENTS

The author thanks the following people and organizations: D. W. Caldwell for financial and logistical support, and his knowledge of the New Sharon site; Linwood Wright (landowner) and the Maine Department of Transportation; Sigma Xi (Boston University and National Chapters) for financial support; Bob Newton for use of XRD lab at Smith College; Bob Nelson for pollen analysis; Ed Laine and Arthur Hussey for use of facilities at Bowdoin College; Ardith K. Hansel (Illinois State Geological Survey) for equal-area net and eigenvalue computer programs; useful field discussions with Hal Borns, Woody Thompson, Mike Clinch, and Mike Retelle; support from the Maine Geological Survey and State Geologist Walter Anderson, and especially the cartographic staff of the Maine Geological Survey. The author also thanks in particular Woody Thompson, Jack Ridge, and Mike Retelle who reviewed preliminary drafts of this paper and helped organize its content.

REFERENCES CITED


Waterlain glaciogenic sediments and the "New Sharon Soil"


Rappol, M., 1985, Clast-fabric strength in tills and debris flows compared for different environments: Geologie en Mijnbouw, v. 64, p. 327-332.


Thompson, W. B., and Borns, H. W., Jr., 1985b, Surficial geologic map of Maine: Maine Geol. Surv., scale 1:500,000.


APPENDIX A. RESULTS OF POLLEN ANALYSES FROM THE NEW SHARON BEDS BY PERCENTAGE.

<table>
<thead>
<tr>
<th>Sample</th>
<th>NS-4*</th>
<th>NS-12*</th>
<th>PL-60-17**</th>
<th>New Sharon 1*</th>
<th>New Sharon 2*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abies</td>
<td>5.7</td>
<td>3.3</td>
<td>3.5</td>
<td>trace</td>
<td></td>
</tr>
<tr>
<td>Pimus</td>
<td>27.4</td>
<td>33.1</td>
<td>37.9</td>
<td>16.8</td>
<td>35.5</td>
</tr>
<tr>
<td>Picea</td>
<td>61.8</td>
<td>58.0</td>
<td>44.4</td>
<td>4.4</td>
<td>17.5</td>
</tr>
<tr>
<td>Larix</td>
<td></td>
<td>trace</td>
<td>-</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Tsuga</td>
<td></td>
<td>trace</td>
<td>-</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Betula</td>
<td>trace</td>
<td>trace</td>
<td>trace</td>
<td>1.7</td>
<td>4.1</td>
</tr>
<tr>
<td>Alnus</td>
<td>3.8</td>
<td>5.5</td>
<td>13.2</td>
<td>50.8</td>
<td>29.8</td>
</tr>
<tr>
<td>Salix</td>
<td></td>
<td></td>
<td>1.0</td>
<td>trace</td>
<td></td>
</tr>
<tr>
<td>Acer negundo</td>
<td></td>
<td></td>
<td></td>
<td>trace</td>
<td></td>
</tr>
<tr>
<td>Corylus</td>
<td></td>
<td></td>
<td></td>
<td>2.7</td>
<td>trace</td>
</tr>
<tr>
<td>Ostrya</td>
<td></td>
<td></td>
<td></td>
<td>trace</td>
<td></td>
</tr>
<tr>
<td>Tilia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>trace</td>
</tr>
<tr>
<td>Ulmus</td>
<td></td>
<td>trace</td>
<td>trace</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quercus</td>
<td>trace</td>
<td>trace</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myrica</td>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
<td>-</td>
</tr>
<tr>
<td>Cornus</td>
<td></td>
<td></td>
<td></td>
<td>1.4</td>
<td>-</td>
</tr>
<tr>
<td>Prunus</td>
<td></td>
<td></td>
<td></td>
<td>trace</td>
<td></td>
</tr>
<tr>
<td>Ericaceae</td>
<td></td>
<td></td>
<td></td>
<td>1.0</td>
<td>trace</td>
</tr>
</tbody>
</table>

**Poaceae**

<table>
<thead>
<tr>
<th>Sample</th>
<th>NS-4*</th>
<th>NS-12*</th>
<th>PL-60-17**</th>
<th>New Sharon 1*</th>
<th>New Sharon 2*</th>
</tr>
</thead>
<tbody>
<tr>
<td>trace</td>
<td>1.6</td>
<td>1.0</td>
<td>7.7</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>1.6</td>
<td>1.0</td>
<td>5.4</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>trace</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>trace</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.8</td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ferns**

<table>
<thead>
<tr>
<th>Sample</th>
<th>NS-4*</th>
<th>NS-12*</th>
<th>PL-60-17**</th>
<th>New Sharon 1*</th>
<th>New Sharon 2*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>trace</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.5</td>
<td>8.7</td>
<td>4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>trace</td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>1.0</td>
<td>trace</td>
<td>3.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>trace</td>
<td>3.1</td>
<td>11.5</td>
<td>trace</td>
<td></td>
</tr>
</tbody>
</table>

* - D. W. Caldwell, pers. commun., 1985
Trace is less than 1.0%; (-) indicates not observed.

These data are compiled from personal communications to the author or made available to the author with the permission of the individuals involved. In the communications, tentative interpretations have been presented and are included here in paraphrased format, or as partially quoted sections from the letters.

The communication from Terasmae to Caldwell (1960) has been quoted by others (Caldwell, 1960, Borns and Calkin, 1977). The interpretive section reads as follows: "...hemlock is absent or rare. In that regard these assemblages are similar to those found in the Scarborough Beds at Toronto, and the St. Pierre Beds at St. Pierre, Quebec. All assemblages indicate cold climate for the area concerned and hence, should be termed interstadial unless assemblages indicating much warmer climate are also found in the same sediment sequence. It is interesting to postulate a correlation between the New Sharon interval (New Sharon Beds of this paper) and the St. Pierre Beds, now dated at about 65,000 years B.P."

The communication from Nelson to Weddle (1985) is paraphrased as follows: "...both samples are dominated by alder, pine, and spruce, although the overwhelming dominance of spruce reported by Caldwell and Weddle (1983) is not present. Pine and alder account for about 75% of the total pollen in each sample, with spruce being nowhere near as major a component as it was in the earlier counts. Both samples are indicative of at least partly open country, possibly parkland but more likely open forest. The eastern alders are all shrubs and prefer moist to wet substrates. Neither they nor the pines are shade tolerant. The fact that the alders are so important in both counts indicates that at least locally there were nonforested conditions, though possibly just a local boggy area on a small stream floodplain. The lack of major amounts of grass and sedge pollen is important, since they would normally dominate floodplain environments; in this case, the alders were apparently dense enough to suppress most herbaceous undergrowth. The composites, though minor elements in the pollen flora, are small pollen producers but are also most commonly found growing on sunny and well-drained sites. The dogwood pollen could well be derived from *Cornus canadensis*, a boreal shrublet found far north of here today. The few scattered grains of *Corylus* and *Acer negundo* may merely be indicative of the presence of rare in-
Waterlain glacigenic sediments and the "New Sharon Soil"

dividuals at the limits of their distribution. The individual grains of *Tilia* and *Ulmus* could be due to either long-distance transport or possibly reworking; either way, single grains are not considered significant.

In sum, the assemblage would probably be of an environment perhaps comparable to uplands of modern northern Maine or adjacent Canada, beyond the elevational or latitudinal limits of most hardwoods such as maple and oak. Labrador or Newfoundland might be reasonable approximations. The conditions indicated are definitely interstadial rather than interglacial, although harsher (probably colder) than the closed spruce-pine forest indicated by the counts of *Terasmae* and Caldwell that were reported in Caldwell and Weddle (1983). The nonforested areas seem to have been dominated by alder thickets, otherwise there would be more grass and sedge pollen as well as other herbaceous types. It is not clear why pine is dominant over spruce in these

APPENDIX B. FIELD BORING LOG FOR 1987 USGS TEST BORING AT NEW SHARON, MAINE*

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sample**</th>
<th>Blows/15 cm</th>
<th>Description and comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 3.9 m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cuttings; brown to tan, silty, rounded medium- to coarse-grained sand; drilling rate change at 2.1 meters (m); stream alluvium.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Driller notes boulders; cuttings, tan to light gray, silty, rounded fine- to medium-grained sand, drilling rate change at 3.9 m; stream alluvium.</td>
</tr>
<tr>
<td>3.9 - 11.4 m</td>
<td>SS1</td>
<td>4,6,6,23</td>
<td>Sample interval 4.5 - 5.1 m; compact, gray, fine, sandy, slightly clayey silt, few subangular pebbles; diamicton.</td>
</tr>
<tr>
<td></td>
<td>SS2</td>
<td>4,4,4,6</td>
<td>Sample interval 5.4 - 6.0 m; same as SS1, gray diamicton.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.0 m depth equivalent to surface elevation of New Sharon Beds at Site B; no change in drilling rate between SS1 and SS3).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SS3</td>
<td>4,4,5,8</td>
<td>Sample interval 6.9 - 7.5 m; same as SS2, dark gray diamicton.</td>
</tr>
<tr>
<td></td>
<td>SS4</td>
<td>5,5,5,6</td>
<td>Sample interval 8.5 - 9.1 m; Interbedded gray, fine-grained sand, silt, and clay (0 - 0.3 m); compact gray diamicton, same as SS3 (0.3 - 0.6 m).</td>
</tr>
<tr>
<td></td>
<td>SS5</td>
<td>5,6,14,35/4</td>
<td>Sample interval 10.0 - 10.6 m; same as lower part of SS4, compact gray diamicton.</td>
</tr>
<tr>
<td></td>
<td>SS6</td>
<td>4,7,100/2</td>
<td>Sample interval 11.2 - 11.4 m; same as SS5, compact gray diamicton.</td>
</tr>
</tbody>
</table>

| 11.4 m |          |             | Boring terminated; driller notes refusal on boulder. |

** - Surface elevation approximately 94 meters above sea level.

** - Samples collected by split-spoon sampler (SS#) advanced 60 cm by the weight of a 63.5 kg hammer dropped 76 cm; number of blows recorded every 15 cm interval.

* Dr. Richard Jagels (Forest Biology, University of Maine) examined wood fragments extracted from the New Sharon Beds in 1985 and found that they were too dessicated to be identifiable.