3-1-1969

TB35: Alpine Soils on Saddleback Mountain, Maine

J. G. Bockheim
R. A. Struchtemeyer

Follow this and additional works at: https://digitalcommons.library.umaine.edu/aes_techbulletin

Part of the Soil Science Commons

Recommended Citation

This Article is brought to you for free and open access by DigitalCommons@UMaine. It has been accepted for inclusion in Technical Bulletins by an authorized administrator of DigitalCommons@UMaine. For more information, please contact um.library.technical.services@maine.edu.
CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>Description of area</td>
<td>3</td>
</tr>
<tr>
<td>Location</td>
<td>3</td>
</tr>
<tr>
<td>Climate</td>
<td>4</td>
</tr>
<tr>
<td>Geology</td>
<td>4</td>
</tr>
<tr>
<td>Methods</td>
<td>5</td>
</tr>
<tr>
<td>Results and discussion</td>
<td>5</td>
</tr>
<tr>
<td>Alpine turf soil</td>
<td>5</td>
</tr>
<tr>
<td>Alpine lag gravel</td>
<td>9</td>
</tr>
<tr>
<td>Soils associated with patterned ground</td>
<td>9</td>
</tr>
<tr>
<td>Alpine bog soils</td>
<td>12</td>
</tr>
<tr>
<td>Conclusions</td>
<td>14-15</td>
</tr>
<tr>
<td>Literature Cited</td>
<td>16</td>
</tr>
</tbody>
</table>
ACKNOWLEDGMENTS

Gratitude is expressed to Dr. F C. Ugolini, Associate Professor of Forest Soils at the University of Washington, for his suggestions and review of the manuscript.

The authors appreciate the assistance rendered by workers of the Saddleback Ski Corporation and the kindness of Hudson Pulp and Paper Company for permitting use of their land.
APLINE SOILS ON SADDLEBACK MOUNTAIN, MAINE

J. G. Bockheim and R. A. Struchtemeyer

INTRODUCTION

Alpine regions do exist in the northeast, but are less extensive than in western United States and Alaska. Although the areal extent of alpine soils is not known in Maine, nearly 1.4 million acres of land are classified by the Soil Conservation Service as "mountainous."

The importance of land areas at higher elevations is less obvious than at lower altitudes. It seems likely that land unsuitable for agricultural and suburban development will be conserved through multiple use forest management.

From a research standpoint, studies of high mountain regions combine a number of disciplines, including plant ecology, geology, soil science, hydrology and meteorology. This coordination of effort is essential for an understanding of landform development and production of human essentials.

Knowledge of steepland soils enables paleopedologists to reconstruct past climates. Mountainous areas are important as operational bases for the military, particularly with regards to mobility of forces and functioning of equipment in extreme environments.

Alpine regions are located above the zone of normal tree growth and below the area of permanent snow. Ordinarily, alpine regions are characterized by intense winds, tree damage resulting from wind-driven snow and ice crystals, bare rock exposures, snow slides, persistent snow-banks, very steep slopes and fires.

In Maine several mountains with subsidiary peaks greater than 4,000 feet in elevation support alpine zones, including Katahdin (5,267 and 4,751), Sugarloaf (4,237), Bigelow (4,150 and 4,088), North Brother (4,143), Saddleback (4,116 and 4,023) and Abraham (4,089).

DESCRIPTION OF AREA

Location. Highest elevations of the Saddleback Range are located in Sandy River Plantation, seven and a half miles southeast of the
village of Rangeley in western Maine. Rising 4,116 feet above sea level, Saddleback Peak is Maine’s eighth highest. Separated from Saddleback Peak by a “saddle” or col, the Horn (4,023 feet) is the next major summit in the range. Farther to the northeast are Saddleback Junior (3,640 feet) and Poplar Ridge (3,120 feet).

**Climate.** Although no information describing the year-round climate of Saddleback is available, Fobes (1946) reported climatic data for the region known as the Northern Maine Climatic Area. Mean annual temperature of north-western Maine is 38.9°F With an alpine temperature lapse rate of 3°F per 1,000 feet in elevation, the mean annual temperature at the summit of Saddleback may well be less than 30°F.

The dominant climatic element of northwestern Maine is snow, unofficially averaging 144 inches per year at the ski area located near the base of Saddleback Mountain. Mean annual rainfall in northwestern Maine is 36.5 inches. Due to orographic rainfall, Saddleback receives more precipitation than the neighboring lowlands.

Whereas lowland areas experience an average of 120 clear days (less than 0.3 cloudiness) a year, the summit of Saddleback is more apt to be shrouded with clouds.

In addition to low temperatures, high precipitation, and heavy fog, strong winds sweep across the Saddleback Range. Prevailing winds are from the northwest in the winter and southwest in the summer.

**Geology.** Occurring as isolated peaks and short ranges, the mountains of western Maine are a continuation of the White Mountains of New Hampshire. Intruded as a core beneath overlying strata during Middle Devonian time, the main ridge of Saddleback is composed of a medium- to coarse-grained, light gray, porphyritic granite (Colombini, 1961). A considerable area of the overlying rock was strongly metamorphosed to a lithologically resistant hornfel.

The last of the massive ice sheets pushed across western Maine approximately 9,000 years ago. It was proposed by Colombini (1961) that Saddleback Peak may have been a subsidiary center of accumulation and outflow of minor alpine glaciers. Enough energy may have developed to pluck material from the top and sides of the mountain and transport glacial drift in several directions.

Felsenmeer is found above 3,900 feet on Saddleback Peak, below which is glacial till. According to Leavitt and Perkins (1935), the distribution of till in Maine is related to topography. While no till has been found above tree line on Saddleback Peak, rhyolite erratics were identified in the till material at 3,500 feet in the saddle.

---

4 Includes records averaged from weather stations in Houlton, Presque Isle, Caribou, Fort Kent, Jackman, Eustis, Brasso Dam and The Forks. 1914-1944.
In the alpine zone of Saddleback Mountain, congelification, solifluction and cryoturbation are dominant processes of post-glacial erosion. Although it is doubtful that permanently frozen ground exist on Saddleback Mountain, it is likely that climafrost has persisted for intermittent periods. Climafrost indicates temporarily frozen conditions often exceeding one year (Lindsay and Odynsky, 1965).

METHODS

Field work was accomplished during the period from July, 1966 to October, 1967. Representative soil profiles were selected within the study area following examination with a soil auger and were described according to the procedure outlined in the Soil Survey Manual (Soil Survey Staff, 1951 and 1962).

The procedure for sampling soils was similar to that described by Lyford (1964). Through a vertical section of the profile, a one-foot square sample was taken from each horizon. Following sieving and weighing, two one-quart samples were collected from each horizon for laboratory analysis. Sub-samples were used to determine moisture content at the time of sampling. From five to ten clods were removed carefully from each horizon for bulk density determination.

All chemical and physical determinations, with the exception of bulk density, were completed on the soil fraction composed of particles less than two millimeters in diameter.

The following physical determinations were completed on the aforementioned samples: particle-size distribution by the hydrometer method (Bouyoucos, 1951); field capacity, wilting capacity and available moisture on moisture tension apparatus described by Peters (1965); bulk density by the paraffin-coated clod technique (Blake, 1965); and per cent by weight of coarse material greater than two millimeters in diameter.

Chemical measurements included soil reaction on a paste composed of two parts of water to one part of soil and analyzed on a Fisher Accumet, Model 310, glass elecrode pH meter; and organic matter by per cent loss upon ignition at 400° C for at least eight hours.

RESULTS AND DISCUSSION

Alpine Turf Soil. Of the alpine soils forming a catena above timber line at approximately 4,000 feet on Saddleback Mountain, the alpine turf soil is the most common member and is well to somewhat excessively drained. Field descriptions and laboratory data for two alpine turf profiles appear in tables 1, 2, 3 and 4.

Alpine turf soils on Saddleback Mountain are very shallow to
moderately deep, ranging from several inches to a little over two feet in depth. Having developed from a coarse grained, porphyritic granite, these soils are thought to be residual. Similar soils are developed in granite on Mt. Bigelow and Mt. Abraham and in schist on Sugarloaf Mountain.

A variety of alpine flora form climax communities on alpine turf soils, including grasses, sedges, lichens, and other perennials. In slight depressions with better protection from the wind, there are dwarf trees such as balsam fir (Abies balsamea (L.) Mill.), black spruce (Picea mariana (Mill.) B.S.P.) and mountain paper birch (Betula papyrifera var. cordifolia (Regel) Fern.).

Alpine turf soils are found on moderate to steep slopes, ranging from 20 to more than 30%.

As shown in figure 1, a typical profile is composed of 01, 02, A1 (traces of an A2 are visible), B21hir and B22hirf horizons overlying bedrock. An extremely fine-textured dark brown soil was commonly found in fissures of the bedrock.

Fig. 1. Partially frozen alpine turf soil; 3950 ft. Saddleback Mt.
Table 1. Soil characteristics of an alpine turf profile, plot 1T-1.

Location: Saddleback Mountain; Rangeley, Maine
Vegetation: Alpine flora
Parent material: Residuum from porphyritic granite
Topography: 20° slope, concave, aspect 335°/Az., elevation 4,100 feet
Drainage: Somewhat excessively drained

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>6½-3½“</td>
<td>Greasy mor</td>
</tr>
<tr>
<td>02</td>
<td>3½-0”</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>0-5”</td>
<td>Black (5YR 2/1) sandy loam; weak, medium crumb structure; friable; extremely acid; abrupt, smooth boundary; many roots; organic concretions; abundance of vermiculite flakes.</td>
</tr>
<tr>
<td>B2hir</td>
<td>5-9”</td>
<td>Very dusky red (2.5YR 2/2) loam; moderate, fine crumb structure; very friable; extremely acid; abrupt, broken boundary; many roots compacted atop regolith; iron concretions.</td>
</tr>
<tr>
<td>R</td>
<td>9+</td>
<td>Weathered granite; dark red (7.5Y 4/4) soil present in fractures.</td>
</tr>
</tbody>
</table>

Table 2. Soil characteristics of an alpine turf profile, plot 2T-1.

Location: Saddleback Mountain; Rangeley, Maine
Vegetation: Alpine flora
Parent material: Residuum from porphyritic granite
Topography: 28° slope, straight, aspect 326°/Az., elevation 4,100 feet
Drainage: Somewhat excessively drained

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>6½-5½“</td>
<td>Greasy mor</td>
</tr>
<tr>
<td>02</td>
<td>5½-0”</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>0-4”</td>
<td>Dark reddish brown (5YR 3/2—dry) sandy loam; weak, fine crumb structure; very friable; extremely acid; clear, smooth boundary; many roots; organic concretions.</td>
</tr>
<tr>
<td>B21hir</td>
<td>4-13”</td>
<td>Dark reddish brown (5YR 3/3—dry) sandy loam; weak, fine crumb structure; very friable; extremely acid; clear, smooth boundary; few roots.</td>
</tr>
<tr>
<td>B22hirf</td>
<td>13-24”</td>
<td>Dark reddish brown (5YR 3/4—dry) silt loam; weak, fine crumb to weak, fine platy structure; friable; extremely acid; abrupt, wavy boundary contiguous with bedrock; no roots.</td>
</tr>
<tr>
<td>R</td>
<td>24+</td>
<td>Weathered granite.</td>
</tr>
</tbody>
</table>
Table 3. Analyses of an alpine turf profile, plot 1T-1.

<table>
<thead>
<tr>
<th>Depth (in.)</th>
<th>% sand, silt and clay</th>
<th>Bulk density (gm./cc.)</th>
<th>pH</th>
<th>% loss upon ignition</th>
<th>Per cent moisture dry weight basis .33 atm.</th>
<th>15 atm.</th>
<th>% coarse skeleton (wt.) (&gt;2mm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>68-18-14</td>
<td>1.09</td>
<td>3.82</td>
<td>28.5</td>
<td>55.0</td>
<td>28.6</td>
<td>87.7</td>
</tr>
<tr>
<td>5-9</td>
<td>44-41-15</td>
<td>1.08</td>
<td>4.42</td>
<td>14.2</td>
<td>36.7</td>
<td>11.3</td>
<td>34.0</td>
</tr>
</tbody>
</table>

Table 4. Analyses of an alpine turf profile, plot 2T-1.

<table>
<thead>
<tr>
<th>Depth (in.)</th>
<th>% sand, silt and clay</th>
<th>Bulk density (gm./cc.)</th>
<th>pH</th>
<th>% loss upon ignition</th>
<th>Per cent moisture dry weight basis .33 atm.</th>
<th>15 atm.</th>
<th>% coarse skeleton (wt.) (&gt;2mm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>70-20-10</td>
<td>1.07</td>
<td>3.48</td>
<td>25.3</td>
<td>42.8</td>
<td>25.9</td>
<td>76.5</td>
</tr>
<tr>
<td>4-13</td>
<td>59-33-8</td>
<td>0.88</td>
<td>4.45</td>
<td>29.1</td>
<td>32.6</td>
<td>17.4</td>
<td>84.2</td>
</tr>
<tr>
<td>13-24</td>
<td>40-52-8</td>
<td>1.31</td>
<td>4.34</td>
<td>17.0</td>
<td>22.5</td>
<td>11.6</td>
<td>88.7</td>
</tr>
</tbody>
</table>
Unlike soils of lower elevations, alpine turf soils support thick organic horizons. The 01 and 02 layers taken collectively often were greater than six inches.

The most outstanding feature of alpine soils was an abundance of organic matter throughout the profiles. Organic matter contents often exceeded 20% in the A1 horizon, decreasing with depth. As a result of a preponderance of humic substances, horizonation was made difficult, colors could not be taken under moist conditions, and field textures were difficult to establish.

Alpine turf soils in the Saddleback Range were extremely acid, ranging from 3.7 in the surface mineral horizon to 4.4 in the lower part of the solum.

Illuvial horizons of alpine turf soils exhibited strong coloring, probably due to concentrations of organic matter and free iron. Platiness in lower B horizons appeared to be associated with the occurrence of frost. Where frozen ground was not detected, an abundance of moisture filled interstices between plates.

Concretions were common throughout alpine turf profiles. It was observed that in the A1 horizon these nodules were composed almost entirely of organic matter, the B horizons contained iron-enriched concretions.

Clay contents were low throughout the profiles, probably contributing to the loose, dust-like consistence of alpine turf soils. An abundance of shiny vermiculite flakes was peculiar to surface mineral horizons of these soils.

Alpine turf soils at high elevations in the Saddleback Range contained a predominance of coarse materials. Nearly 80% of the horizons analyzed in the field and in the laboratory contained by weight 75% or more coarse fragments greater than two millimeters in diameter.

In addition to alpine turf soils, the following soils were identified above tree line on Saddleback Mountain: (1) alpine lag gravel, (2) soils associated with patterned ground and (3) alpine bog soils.

**Alpine Lag Gravel.** Nearly 50% of the area above tree line consists of rock outcrop, some of which is colonized by lithophilic vegetation. When products of physical weathering become stabilized by primary vegetation, an alpine lag gravel is formed. As shown in figure 2, these soils appeared to be very young, showed little chemical weathering and were loosened predominantly by physical disintegration. Alpine lag gravels are extremely low in humus and without visible horizonation.

**Soils Associated with Patterned Ground.** According to Washburn (1956) patterned ground is a group term for the somewhat symmetrical forms of material that are generally associated with frost action. The
following forms of patterned ground exist on Saddleback Mountain: non-sorted circles, non-sorted nets, sorted steps and sorted stripes. Similar frost features are present on Bigelow Mountain and Mt. Abraham in western Maine.

Non-sorted circles are patterned ground whose mesh is dominantly circular (Washburn, 1956). The non-sorted appearance is due to the absence of a border of stones such as that characteristic of sorted circles. In the Saddleback Range non-sorted circles are commonly one to several feet in diameter and are believed to be active.

Non-sorted circles may be manifested in the form of "frost scars." As illustrated in figure 3, frost scars are bare exposures of mineral material which may contain a pavement of coarse fragments overlying a layer of peat. Below the peat is a layer of fine-textured soil, followed by coarse fragments in a matrix of fines.

A second type of frost scar is one in which the peaty surface is made shiny by flakes of vermiculite. According to Antevs (1932), who
described two types of "vegetative scars" on Mt. Washington, New Hampshire, both frost features result from upheaving of stones.

Soils of active circles where plant cover is minor show little profile development.

In somewhat poorly drained areas above timber line, non-sorted nets are found. Turf hummocks are a particular type of non-sorted net with a mesh characterized by a three-dimensional, knob-like shape and a cover of vegetation (Washburn, 1956).

Troll (1958) described their occurrence as resulting from frost heaving and wind. Fine, crumbly soils are lifted by "pipkrake" or needle ice and eroded by wind. Soils protected from rain by overhanging turf roots may form mounds or hummocks up to several feet in height. While mounds a foot in height are found in the col (see figure 4), smaller turf hummocks occur in several areas of the Saddleback Range.

On slopes ranging from 5 to 15 degrees, circles and nets may be drawn downslope by solifluxion into tongue-like or elliptical shapes
known as sorted steps or stone garlands and felsenmeer terraces (Thompson, 1960). A sorted step occurring on Saddleback Mountain appears in figure 5.

On steeper slopes outbreaks in the boulder windrows may form sorted stripes. As illustrated in figure 6, two stripes may unite downslope and form a horseshoe-shaped pattern.

The assessment of age is a major problem with the interpretation of patterned ground. Frost action was evidently more intensive immediately following glaciation than it is today. Most investigators attribute the larger block nets, stripes and lobes to periglacial frost phenomena (Antevs, 1932; Goldthwait, et. al., 1951). Numerous studies have indicated that patterned ground is presently active in many mountainous areas of the United States (e.g. Billings, et. al., 1946; Bliss, 1963; Denny, 1940; Goldthwait, et. al., 1951; Thompson, 1960).

**Alpine Bog Soils.** Occurring mainly in the col and on the northern aspect of the Horn, alpine bogs such as that of figure 7 are of limited
extent in the Saddleback Range. Alpine bogs are composed of open, shallow water interspersed with patches of sedge, willow and alders. Waterlogged throughout the summer, alpine bog soils occur in flat areas, at the headwaters of streams, and in depressions behind terrace-like ridges on steep slopes (Retzer, 1950). Where bog soils do not surround a permanent or seasonal water hole or pond, they obtain their water from seepage.

Retzer (1950) and Harshberger (1919) have given descriptions of alpine bog soils. Because of low temperatures, a raw brown peat is formed near the bog surface. Subsoils are often highly mottled. Although A-C profiles have been reported, standard nomenclature cannot be ascribed to most alpine bog soils.
Fig. 6. Stone horseshoe

Fig. 7. An alpine bog, Saddleback Mt.
CONCLUSIONS

A variety of alpine soils were observed on Saddleback Mountain in western Maine. Since parent material, climate and time appear to be relatively constant throughout the area above timber line, topography—and its effect upon soil drainage—may exert the greatest influence upon soil development and the distribution of vegetative patterns.

Nearly 50% of the area above tree line on Saddleback Mountain consists of rock outcrop, some of which is colonized by lithophilic vegetation. When the products of physical weathering become stabilized, an alpine lag gravel is formed. These soils also occur in wind-swept areas where physical disintegration is particularly intensive.

Well drained to somewhat excessively drained alpine turf soils are formed on moderate to steep slopes. Developed from a coarse-grained, porphyritic granite, these soils are thought to be residual. A variety of alpine flora, including grasses, sedges, lichens and other perennials, form climax communities on alpine turf soils.

While low in clay, alpine turf soils in the Saddleback Range contained an abundance of organic matter and skeletal components. In addition these soils were extremely acid and often frozen in the lower horizons. Concretions were common throughout alpine turf profiles.

The following manifestations of patterned ground exist on Saddleback Mountain: non-sorted circles, non-sorted nets, sorted steps and sorted stripes. Most investigators associate these forms of patterned ground in the northeast to periglacial frost phenomena. Active frost-induced patterns are manifested in frost scars and turf hummocks, both of which occur in the alpine zone on Saddleback Mountain. Patterned ground and vegetative distribution are predominantly dependent upon slope and availability of soil moisture.

Alpine bogs are of limited extent in the Saddleback Range and occur mainly in the col and on the northern aspect of the Horn. Alpine bogs are composed of open, shallow water interspersed with patches of sedge, willow and alders.
Literature Cited


