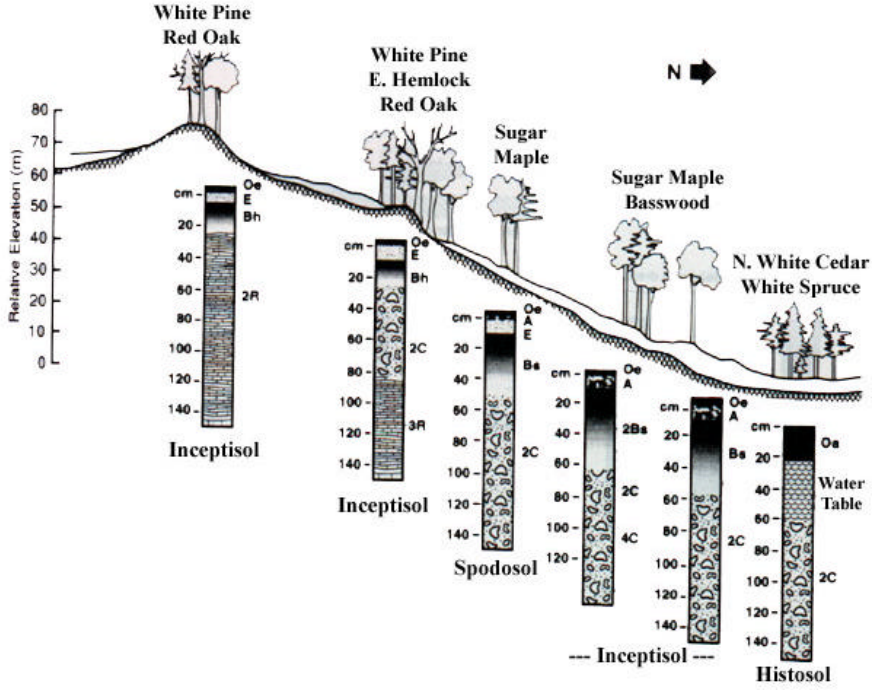
# Soil Profile Descriptions

Soils develop in parent material from the time of its deposition under the influence of local climate, topography, and biota. The process of soil development is often refered to as soil weathering. Over time, a number of environmental forces act to create distinct layers or horizons parallel to the soil surface. This occurs through the differential downward movement of materials, such as organic matter or clay particles. The movement and accumulation of materials at depth affects soil texture, structure, and/or color. These are three properties that are useful for distinguishing horizons. For example, accumulation of clay affects texture and structure (e.g. Bt) and an accumulation of organic matter affects color (e.g. A, Bh). However, these are not the only soil properties used to distinguish horizons. For example, the depth to parent material (C) in a calcareous till is best determined by testing for the presence of carbonates.

The purpose of this lab is to introduce you to the dirty process of describing soil profiles. The best way to learn it is through practice. Please keep in mind that we are working with nature, which has infinite variety. Anomalies are the norm. You might find horizon boundaries that jog up and around structural roots of trees and large cobblestones. You might have to describe a soil that seems to have more cobbles than mineral soil. Or you might have clay, clay, and more clay. In some cases, you must use your judgement to apply the most appropriate label, however arbitrary it may seem.




The distribution of soils in relation to topographic position in Michigan's Upper Peninsula.

## Assignment

Write a soil profile description. This should be a cooperative effort among your group members. Please follow the style and format of the sample profile description below. Pay close attention to the details of format and be sure to include all of the information in the same order for each horizon description. Include a paragraph briefly describing the site conditions, including landform, parent material, slope, drainage, forest type, and other notable qualities of your site. A typed copy of your group's profile description is due at the beginning of next week's lab.

**Sample Profile Description:**

## Mixed Oak Forest

This mixed oak forest is dominated by *Quercus velutina* and *Q. alba* in the overstory, *Acer rubrum* in the understory, and *Rhus aromatica*, *Carex Pensylvanica*, and *Q. prinoides* in groundcover. The site is located on an upper northwest-facing (20%) slope of a kame. The soil is well drained and is developed in coarse-textured ice-contact material with loamy sand in the upper horizons and gravelly sand in the lower horizons.

**$O_{e/i}$** 3-0 cm; intact and partially decomposed *Q. velutina*, *Q. alba*, and *A. rubrum* leaves; abrupt smooth boundary.

**A** 0-8 cm; dark grayish brown (10YR 4/2) loamy sand, weak fine granular structure; many fine roots; slightly acid; abrupt smooth boundary.

**E** 8-28 cm; brown (10YR 5/3) loamy sand; weak medium granular structure; common fine roots; 2% gravel; medium acid; clear wavy boundary.

**EB** 28-45 cm; yellowish brown (10YR 5/4) loamy sand; weak fine subangular blocky structure; few fine roots; 3% gravel; medium acid; clear wavy boundary

**$Bt_1$** 45-75 cm; dark brown (7.5YR 4/4) gravelly sandy loam; weak coarse subangular blocky structure; few fine roots; 15% gravel; slightly acid; gradual wavy boundary.

**$Bt_2$** 75-90 cm; dark brown (7.5YR 4/4) gravelly sandy loam; weak coarse subangular blocky structure; 15% gravel; neutral; abrupt irregular boundary.

**C** 90 cm; grayish brown (10YR 5/2) gravelly loamy sand; single grain; strong effervescence; moderately alkaline.

# Soil Profile Description Procedure

Complete the Soil Profile Description Form and the Site Description Form using the the following procedure. Please work as a group in completing these forms. Each member of the group should participate in formulating the profile description.

1. Clean off the pit face to expose fresh soil. Dig out the bottom of the pit to expose parent material.
2. Describe soil horizons from top to bottom, as follows:
   A. Identify **O horizons**, if present; measure depth (O horizons are measured down to the surface of the mineral soil; e.g. Oi 3-0 cm); identify composition (e.g. Oe partially decomposed sugar maple litter); and determine boundary (*p. 4*, e.g. abrupt smooth boundary).
   B. Locate **preliminary horizon boundaries** based upon differences in texture, structure, and color, and mark with nails. Assign each horizon a master horizon designation (*pp. 1-2*, e.g. A, E, B, C).
   C. For each preliminary mineral horizon, perform the following determinations:
      i. Break out a handful of soil aggregates and describe **structure**, including grade, size and shape (*p. 6-8*, e.g. weak medium granular structure).
      ii. Determine soil **texture** following the flow chart on the last page of the field guide (*p. 15*, also see *pp. 4-5*, e.g. sandy loam).
      iii. Determine the soil **color** using the *Munsell color chart* (see *p. 4*, e.g. dark yellowish brown 10YR 3/4).
      iv. Estimate **% coarse fragments** in each soil horizon (*p. 4-5*, diagrams on *p. 10*) and apply appropriate modifier for texture (e.g. gravelly sandy loam).
      v. Measure **pH** of each mineral horizon using soil pH test kit and guide, record reaction (*p. 10*, e.g. slightly acid pH 6.2).
      vi. Note presence of **mottling** (*pp. 9-10*), if observed in any horizon, under special features.
   D. Apply **master and subordinate horizon designations,** as appropriate, based upon soil description just completed (*p. 2-3, 11-13*, e.g. Oi, Ap, Bt, Bhs...).
   E. Determine upper **boundary of the C horizon** using the HCl test for carbonates. Note degree of effervescence, if present (*p. 9*), under special features.
   F. Record **depths** of each mineral horizon using the surface of mineral soil as a zero point. (e.g. A 0-10 cm, B 10-30 cm...).
   G. Describe the (lower) **boundary** of each mineral horizon, including *distinctness* and *topography* (*p. 4*, e.g. gradual wavy boundary).

3. Complete the site description form, making notes on landform, topography and vegetation, nutrient regime, drainage, and ecological moisture regime (see drainage classes on *p. 14*).

Examples of Common Master Horizons and Subordinate Distinctions

| Master Horizon | Subordinate Distinctions |
|---|---|
| **O** | **i,e,a** - state of decomposition; used only with O designation, southern and northern MI |
| **A** | **p** - plowing or other disturbance; most often found in southern MI |
| **E** | (subordinate distinctions rarely used) |
| **B** | **t** - silicate clay; northern and southern MI |
| | **h,s** - humus, sesquioxides; northern MI |
| | (**h** has value and chroma of 3 or less) |
| | **w** - development of structure and/or color without evidence of eluviation and illuviation; southern and northern MI |
| **C** | (subordinate distinctions rarely used) |

**Notes:**

**g** - very poorly drained soils where colors are grayish due to presence of reduced iron; could be used with A,E,B,C.

**x** - used for presence of dense, brittle layers known as fragipans; most commonly used with B; found most often in northern lower MI and Upper Peninsula MI soils.

# Soil Horizon Designations

The following are descriptions of the Master Soil Horizons (upper case) and Subordinate Horizon Designations (lower case) that may be applied to them. For cases in which a layer of soil has charactersistics of more than one Master Soil Horizon, the rules for assigning transitional horizons are provided in a section at the end.

**O horizons or layers:** Surface layers of organic material accumulated on top of the surface of either mineral or organic soil. O horizons may consist of undecomposed or partially decomposed litter, such as leaves, needles, twigs, fruit, moss, and lichens. Other O layers, called peat, muck, or mucky peat, are organic material that was deposited underwater and that has decomposed to varying stages. The mineral fraction of such material is only a small percentage of the volume of the material and generally is much less than half of the weight. Some soils consist entirely of material designated as O horizons or layers. A horizon formed by illuviation of organic material into a mineral subsoil (e.g. Bh) is not an O horizon, though some horizons formed in this manner contain much organic matter.

- **a** Highly decomposed organic material of unidentifiable origin.
- **e** Organic material of intermediate decomposition; identifiable; fragmented.
- **i** Slightly decomposed organic material; identifiable; slightly fragmented.

**A horizons:** Mineral horizons that formed at the surface or below an O horizon and (1) are characterized by an accumulation of humified organic matter well mixed with the mineral fraction and not dominated by properties characteristic of E or B horizons (defined below) or (2) have properties resulting from cultivation, pasturing, or similar kinds of disturbance. If a surface horizon has properties of both A and E horizons but the feature emphasized is an accumulation of humified organic matter, it is designated an A horizon.

- **p** disturbance of the surface layer by plowing, pasturing, or similar uses. A disturbed organic horizon is designated Op. A disturbed mineral horizon, even though clearly once a E, B, or C horizon, is designated Ap.

**E horizons:** Mineral horizons in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these, leaving a concentration of sand and silt particules of quartz or other resistant minerals. An E horizon is usually, but not necessarily, lighter in color than an underlying B horizon. In some soils the color is that of the sand and silt particules, but in many soils coats of iron or other compounds mask the color of the primary particles. An E horizon is differentiated from an overlying A horizon by lighter color and lesser amount of organic matter. An E horizon is differentiated from an underlying B horizon by color of higher value or lower chroma, by coarser texture, or by a combination of these properties. An E horizon is commonly near the surface below an O or A horizon and above a B horizon.

**B horizons:** Mineral horizons that have formed below an A, E, or O horizon and are dominated by one or any combination of the following: (1) illuvial accumulation of silicate clay, iron, aluminum, humus, etc. alone or in combination; (2) coatings of sesquioxides that make the horizon conspicuously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons; (3) alteration that forms silicate clay or liberates oxides or both and that forms granular, blocky, or prismatic structure if volume changes accompany changes in moisture content; (4) evidence of removal of carbonates.

- **h** Illuvial accumulation of organic matter. Accumulation of illuvial, amorphous, dispersible organic matter - sesquioxide complexes if the sesquioxide component is dominated by aluminum, but is present only in very small quantities. The organosesquioxide material coats sand and silt particles or may occur as discrete pellets. In some horizons, coatings have coalesced, filled pores, and cemented the horizon. The symbol "h" is also used in combination with "s" as "Bhs" if the amount of sesquioxide component is significant but value/chroma of the horizon are approximately 3/3 or less. “Bh” and “Bhs” horizons usually have hues 7.5 YR or redder.
- **s** Illuvial accumulation of sesquioxides and organic matter. “s” is used if both the organic matter and sesquioxide components are significant and the value/chroma of the horizon is more than 3/3. The symbol may also be used in combination with "h" as described above.
- **t** Accumulation of silicate clay that either has formed in the horizon or has been moved into it by illuviation. The clay can be in the form of coatings on ped surfaces or in pores, lamellae, or bridges between mineral grains.
- **w** Slight accumulation of material, giving rise to a change in color and removal of carbonates. Characteristic of *weakly* developed young soils.

**C horizons:** Horizons, excluding hard bedrock, that are little affected by pedogenic processes and lack properties of O, A, E, or B horizons. Most are mineral layers, but limnic layers, whether organic or inorganic, are included. The material of C layers may be either like or unlike that from which the solum presumably formed. A C horizon may have been modified even if there is no evidence of pedogenesis. Some soils form in material that is already highly weathered, and such material that does not meet the requirements of A, E, or B horizons is designated C. Changes not considered pedogenic are those not related to overlying horizons.

**R Layers:** Hard Bedrock. Granite, basalt, quartzite, and indurated limestone or sandstone are examples of bedrock that are designated R. The bedrock of an R layer is sufficiently coherent when moist to make hand digging with a spade impractical, although it may be chipped or scraped with a spade.

## How to Assign Transitional Horizons

In some cases, layers of soil will be observed which are distinct from overlying or underlying horizons and which have characteristics of more than one master soil horizon, but cannot easily be resolved into two horizons. These layers are usefully described as transitional horizons. In one type of transitional horizon, the properties of an underlying or overlying horizon are superimposed on properties of the other horizon throughout the transition zone. In another type, parts that are characteristic of an overlying or underlying horizon are enclosed by parts that are characteristic of the other horizon. Special conventions are used to designate these kinds of horizons.

1. **Horizons dominated by properties of one master horizon but having subordinate properties of another.** Two capital letter symbols are used, as AB, EB, BE, BC. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. An AB horizon, for example, has characteristics of both an overlying A horizon and an underlying B horizon, but is more like the A than like the B.

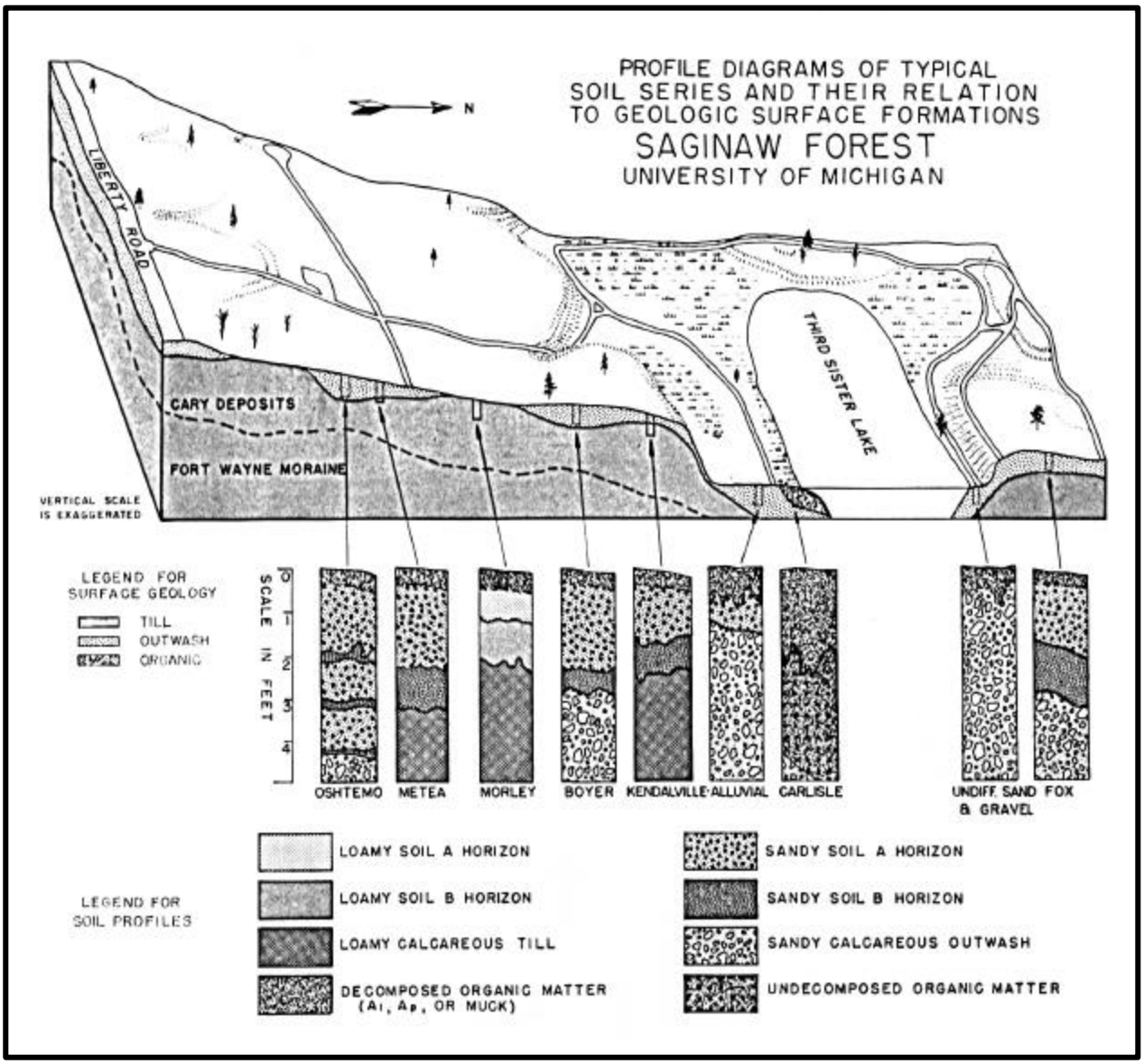
   In some cases, a horizon can be designated as transitional even if one of the master horizons to which it is apparently transitional is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil in which the overlying E horizon has not been removed by erosion. An AB or a BA horizon may be recognized where bedrock underlies the transitional horizon. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent material.

2. **Horizons in which distinct parts have recognizable properties of the two kinds of master horizons indicated by the capital letters.** The two capital letters are separated by a virgule (/), as E/B, B/E, B/C. Most of the individual parts of at least one of the components are surrounded by the other.

   The designation may be used even though horizons similar to one or both of the components are not present, if the separate components can be recognized in the transitional horizon. The first symbol is that of the horizon that makes up the greater volume.

## Lithologic Discontinuities

On occasion, a **lithological discontinuity** is observed which leads to distinct differences in texture and structure between upper and lower horizons, which are unrelated to the processes of weathering following parent material deposition. Such discontinuities arise from consecutive depositions of dissimilar materials, such as outwash over till, within close enough proximity of the soil surface to influence soil horizon development. If a lithologic discontinuity is observed in a Bt horizon, for example, the upper portion would be labelled Bt, while the lower portion and each horizon below it would be given a designation preceded by a 2, such as 2Bt and 2C.


PROFILE DIAGRAMS OF TYPICAL
SOIL SERIES AND THEIR RELATION
TO GEOLOGIC SURFACE FORMATIONS
SAGINAW FOREST
UNIVERSITY OF MICHIGAN
N
LIBERTY ROAD
THIRD SISTER LAKE
CARY DEPOSITS
FORT WAYNE MORAINE
VERTICAL SCALE
IS EXAGGERATED
LEGEND FOR
SURFACE GEOLOGY
TILL
OUTWASH
ORGANIC
SCALE IN FEET
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1
2
3
4
OSHTEMO
METEA
MORLEY
BOYER
KENDALVILLE
ALLUVIAL
CARLISLE
UNDIFF. SAND FOX
& GRAVEL
LEGEND FOR
SOIL PROFILES
LOAMY SOIL A HORIZON
LOAMY SOIL B HORIZON
LOAMY CALCAREOUS TILL
DECOMPOSED ORGANIC MATTER
(A1, Ap, OR MUCK)
SANDY SOIL A HORIZON
SANDY SOIL B HORIZON
SANDY CALCAREOUS OUTWASH
UNDECOMPOSED ORGANIC MATTER

**SITE DESCRIPTION FORM**

Team Name: _____

Lab Day: _____

Investigator(s): _____

Site Location: _____

Stand Description: _____

Landform: _____

Aspect:_____ Slope:_____ % (Note: $45^{o}$ = 100% slope)

**Physiographic position:**
☐ crest
☐ upper slope
☐ mid slope
☐ lower slope
☐ colluvial slope
☐ plain
☐ ravine

**Site surface shape:**
☐ concave
☐ convex
☐ straight

**Topographic position diagram**
(cross-section of slope and surrounding area)

D.R. Zak

# Soil Profile Description Form

| Horizon | Depth (cm) | Structure | Texture | Color | % Coarse Fragments | pH | Boundary | Special Features |
|---|---|---|---|---|---|---|---|---|
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