The Real Dirt On Woods

Exploring the Dynamic World of Forest Soils

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Three Topics of Discussion

- Introduction to Basic Soil Science with emphasis on Forest Soils
- Soils and Forest Productivity
- Soils and Forest Management

Functions of Forest Soils

- Support that holds tree upright
- Provides the mineral nutrients
- Provides water
- Provides air

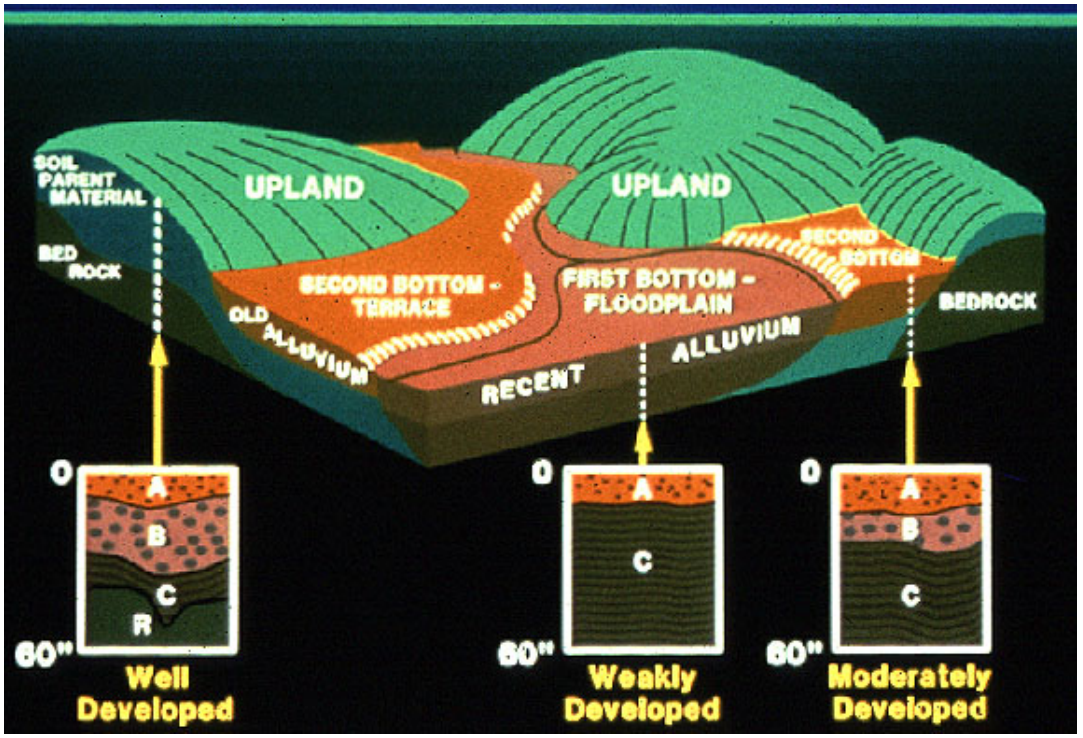
CYCLES

- The Hydrologic, Carbon and Nitrogen cycles comprise sequences of events that are key to making the Earth capable of sustaining life.

- Soils play an important part in each of these cycles.

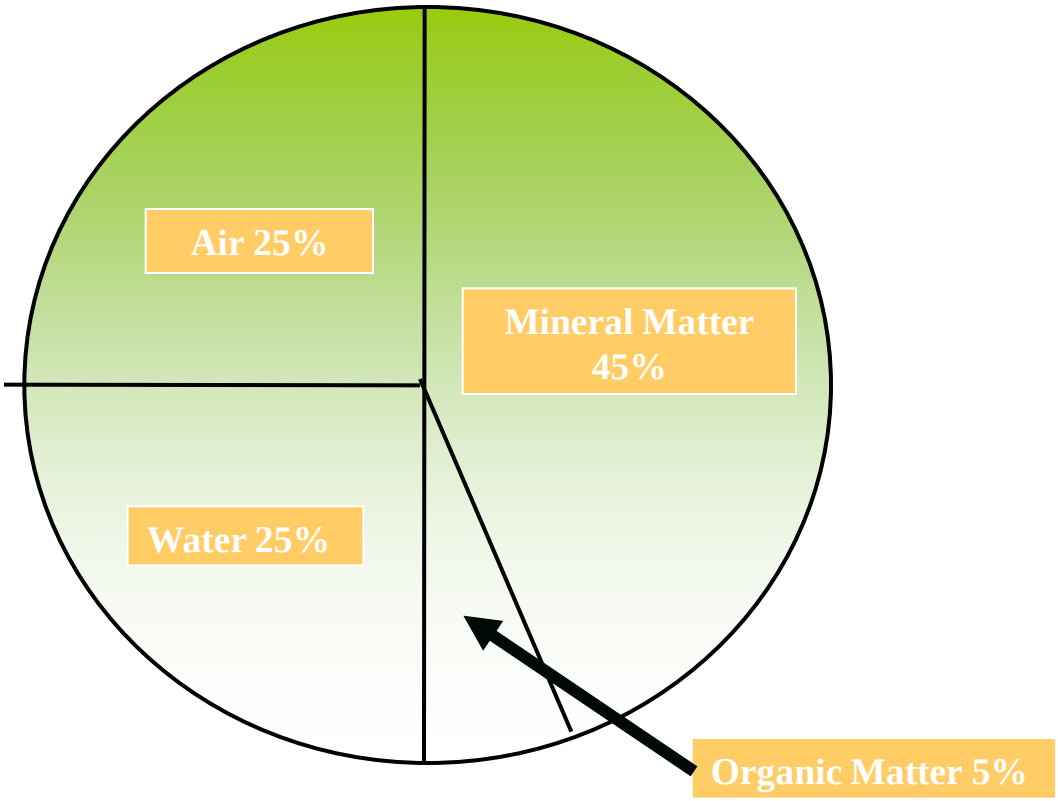
Factors That Influence Soil Formation

- Climate
- Parent material
- Topographic relief
- Organisms
- Time



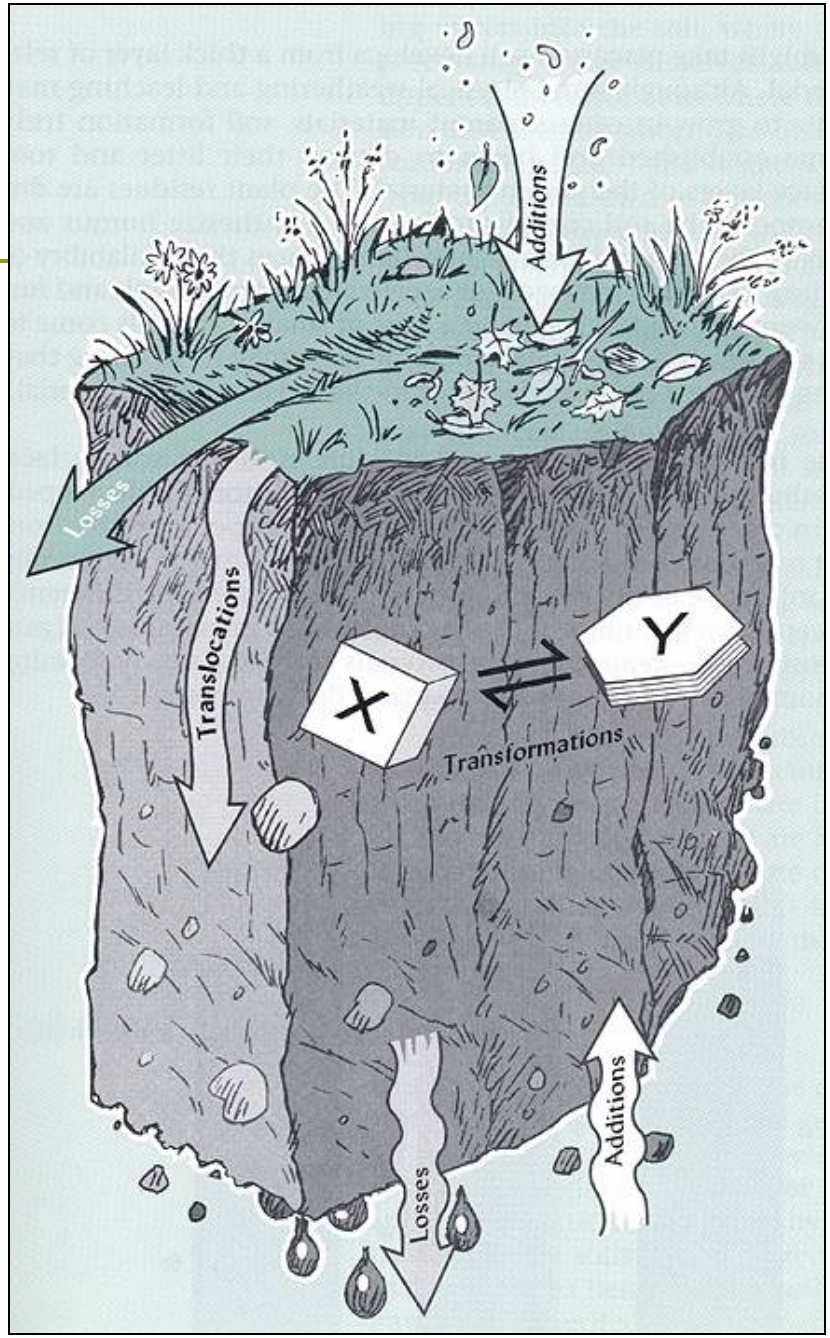
SOIL

- Component definition: Mixture of mineral matter, organic matter, water, and air.
- Example:



Soil Forming Processes

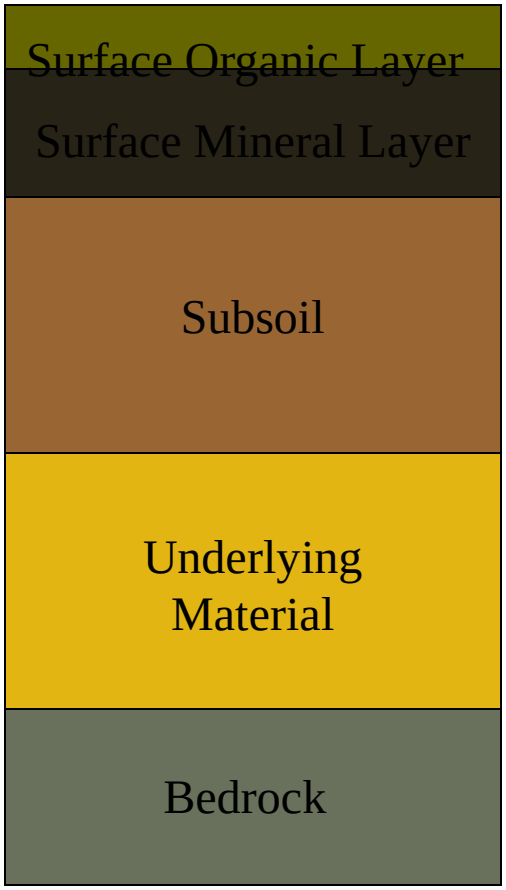
- Translocations
- Transformations
- Additions
- Losses



Key Soil Properties

- Horizons
- Color
- Organic matter
- Texture
- Structure
- Permeability
- Available Water Capacity

Major Horizon Designations



O horizon

A Horizon

B Horizon

C Horizon

R Horizon

A horizon

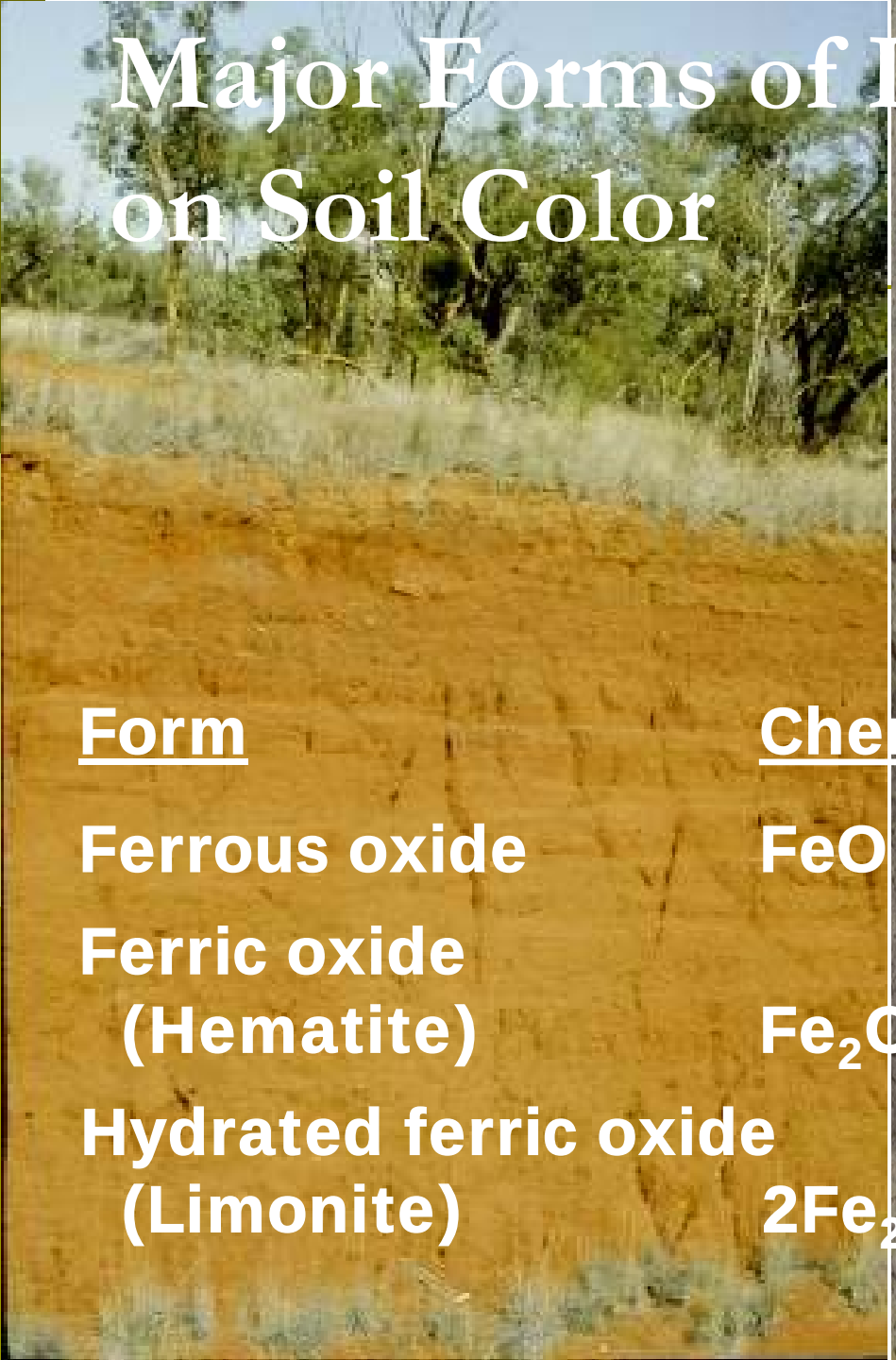
B horizon

C horizon

Significance of Soil Color

- Tells a story of the history of each soil
  - Can be an indication of the degree of weathering. Color changes from weathering are mostly associated with the formation of iron oxides. (parent material and age)
  - Indicator of the amount and distribution of organic matter.
  - Indicator of the degree of aeration or reduction.
  - Light colors can be an indicator of leaching.

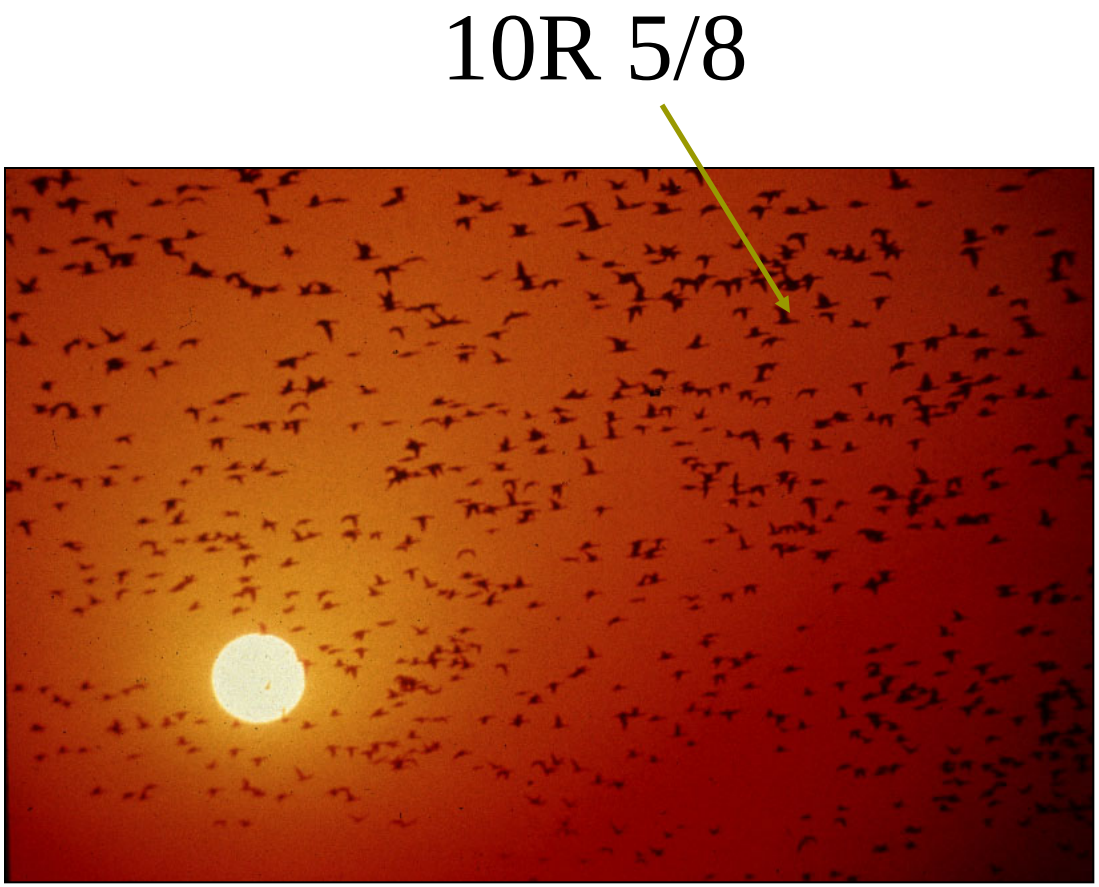
Major Forms of Iron and Effect on Soil Color



Form	Chemical Formula	Color
Ferrous oxide	FeO	Gray
Ferric oxide (Hematite)	Fe_2O_3	Red
Hydrated ferric oxide (Limonite)	$2Fe_2O_3 \cdot 3H_2O$	Yellow

Aspects of Soil Color

- Hue
- Value
- Chroma

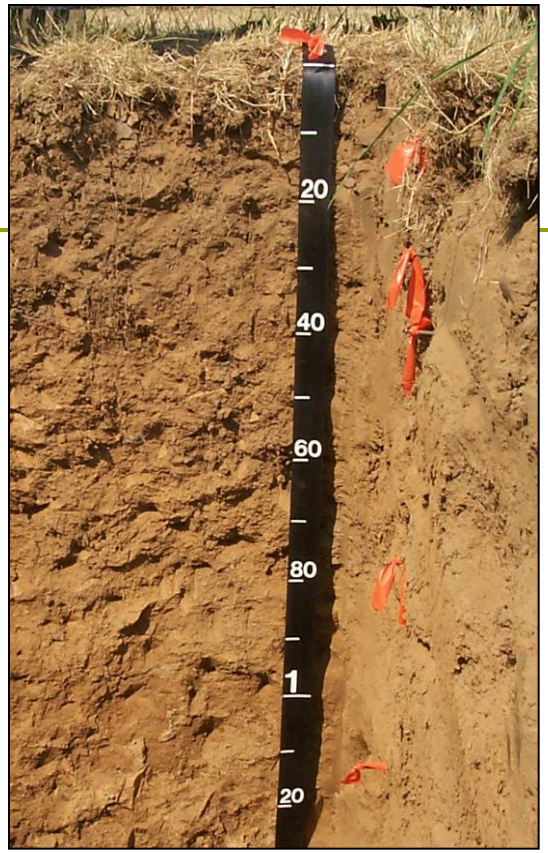


Soil Color

Munsell Soil Color Book

The Munsell notation system is used for recording color.

Hue



Red

0 2.5R 5R 7.5R 10R

Yellow-Red

0 2.5YR 5YR 7.5YR 10YR

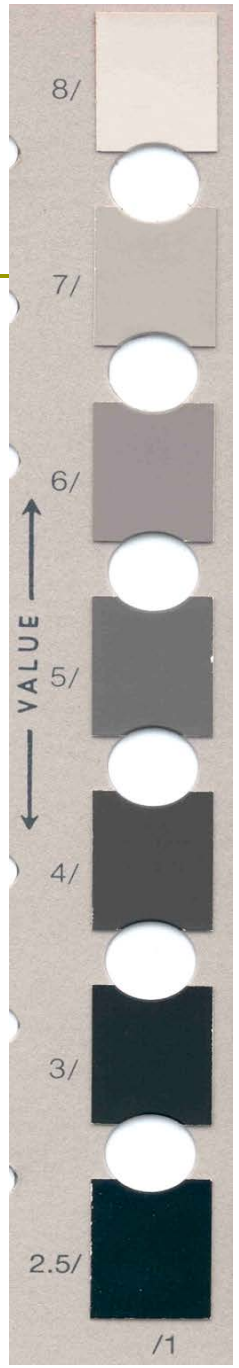
Yellow

0 2.5Y 5Y 7.5Y 10Y

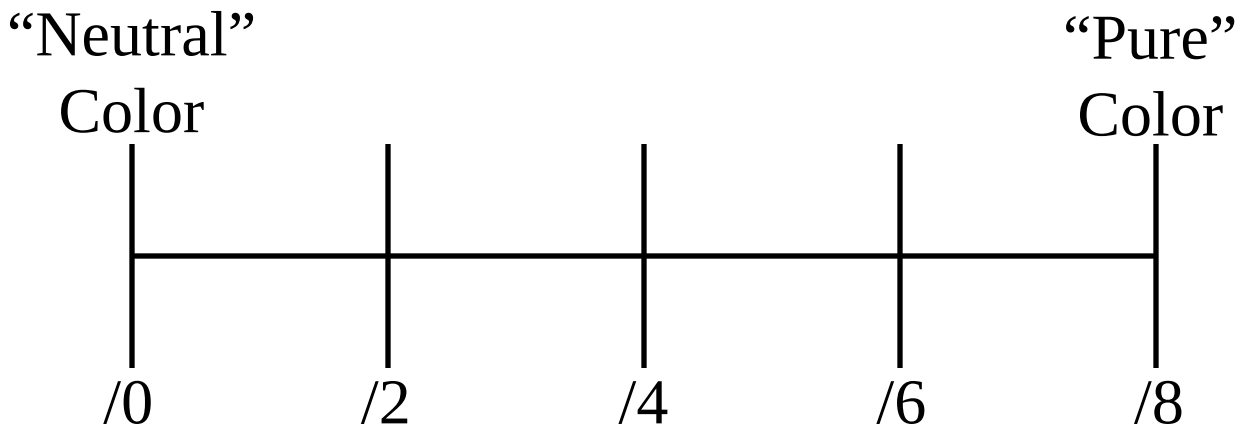
Value

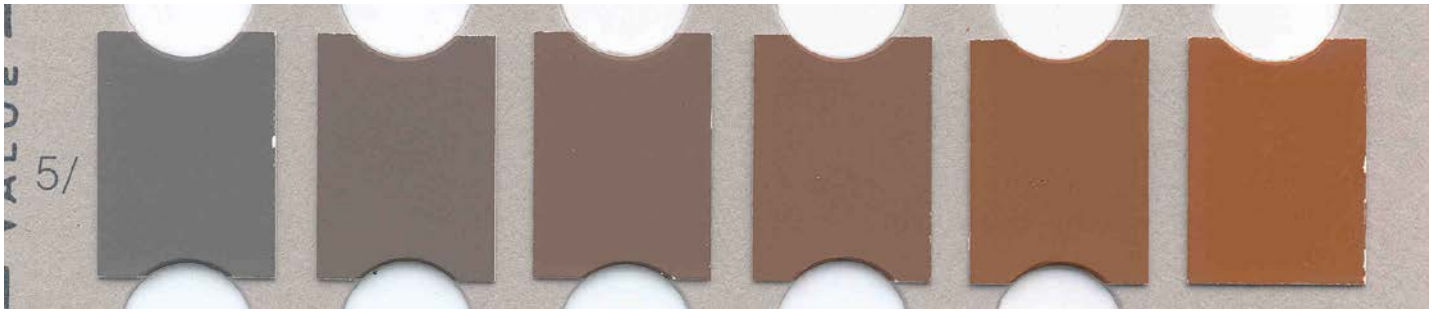
The Lightness or Darkness of Color

- 10/0 - Pure White
- 5/0 - Gray
- 0/0 - Pure Black



Chroma



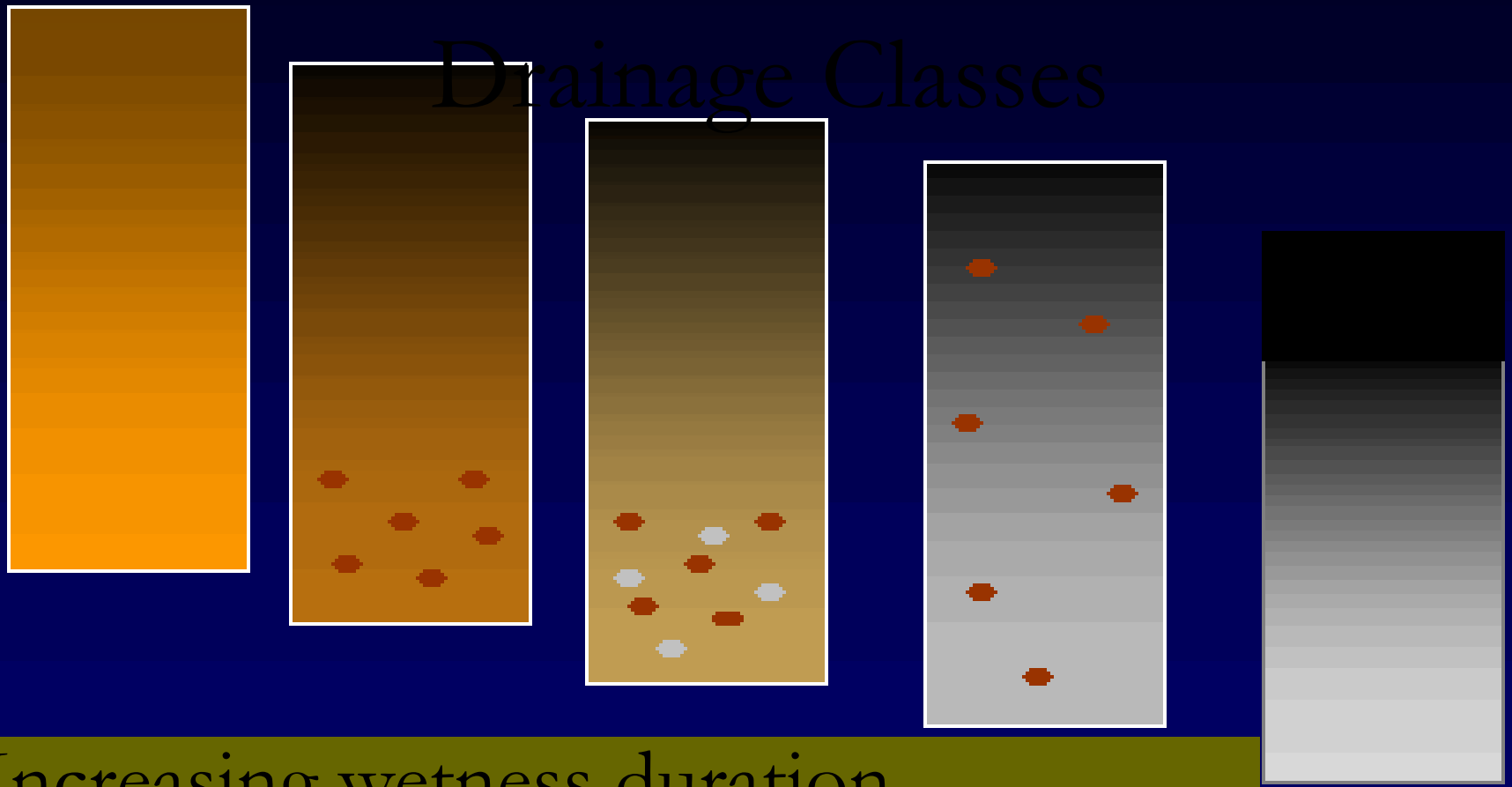


Increasing grayness

Using Soil Color as a Wetness Indicator

- Soils that have seasonal high water tables or long periods of saturation commonly develop particular color patterns.
- These color patterns can help to identify soils that are seasonally wet when examined during the dry periods of the year.
- Color patterns caused by wetness are called “redoximorphic features”.

Soil Drainage Sequence



Increasing wetness duration

Redox concentrations – reddish brown

Redox depletions – grayish colors

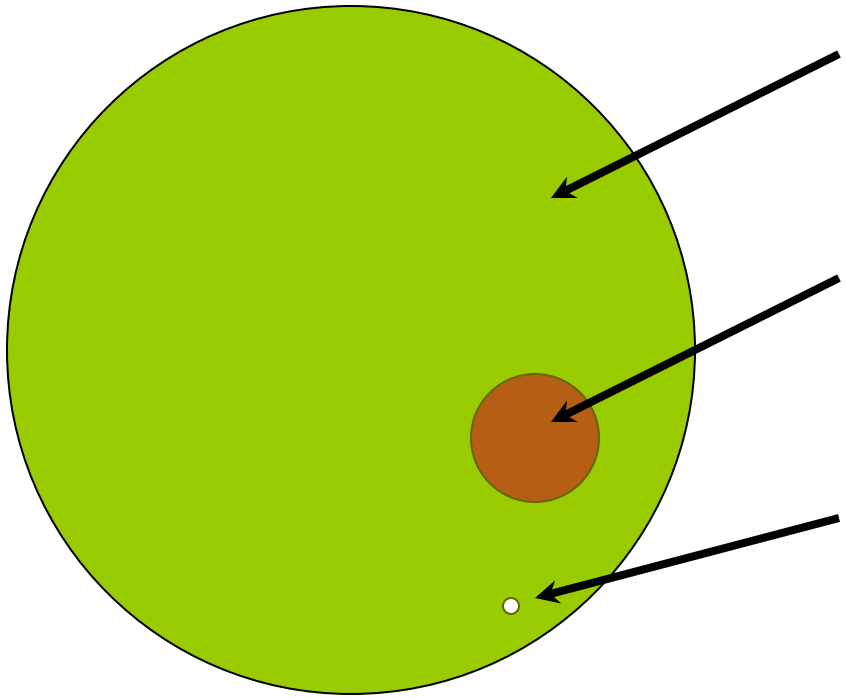
Gleyed Matrix – iron is in a reduced form, causing the grayish to blue hues. Usually the result of prolonged saturation.

Thick, black surface horizon over gray subsoil is an indicator of soil wetness

Soil Texture

- Soil texture is an expression of the proportion of sand, silt, and clay.
- It is probably the most important of all soil physical properties.
- It affects the ability of the soil to hold water and plant nutrients.
- It affects the movement of air and water through the soil.

Relative Sizes of Soil Particles



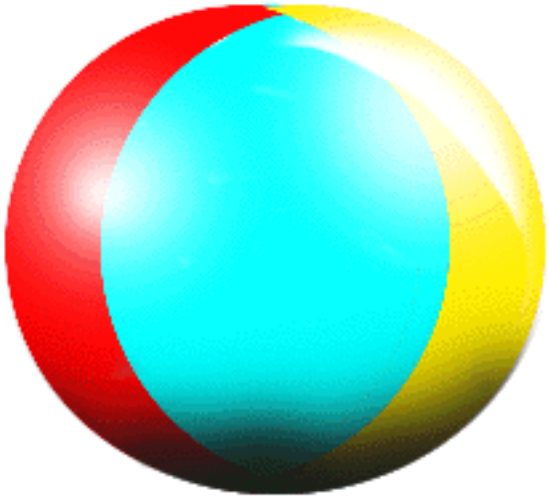
Sand (0.05-2.00 mm)

Silt (0.002-0.05 mm)

Clay (<0.002 mm)

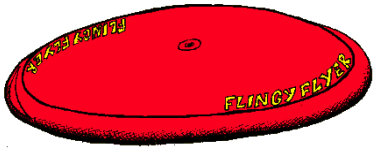
Relative Sizes of Particles

beach ball



Sand
(feels gritty)
(2.00 - 0.05 mm)

frisbee

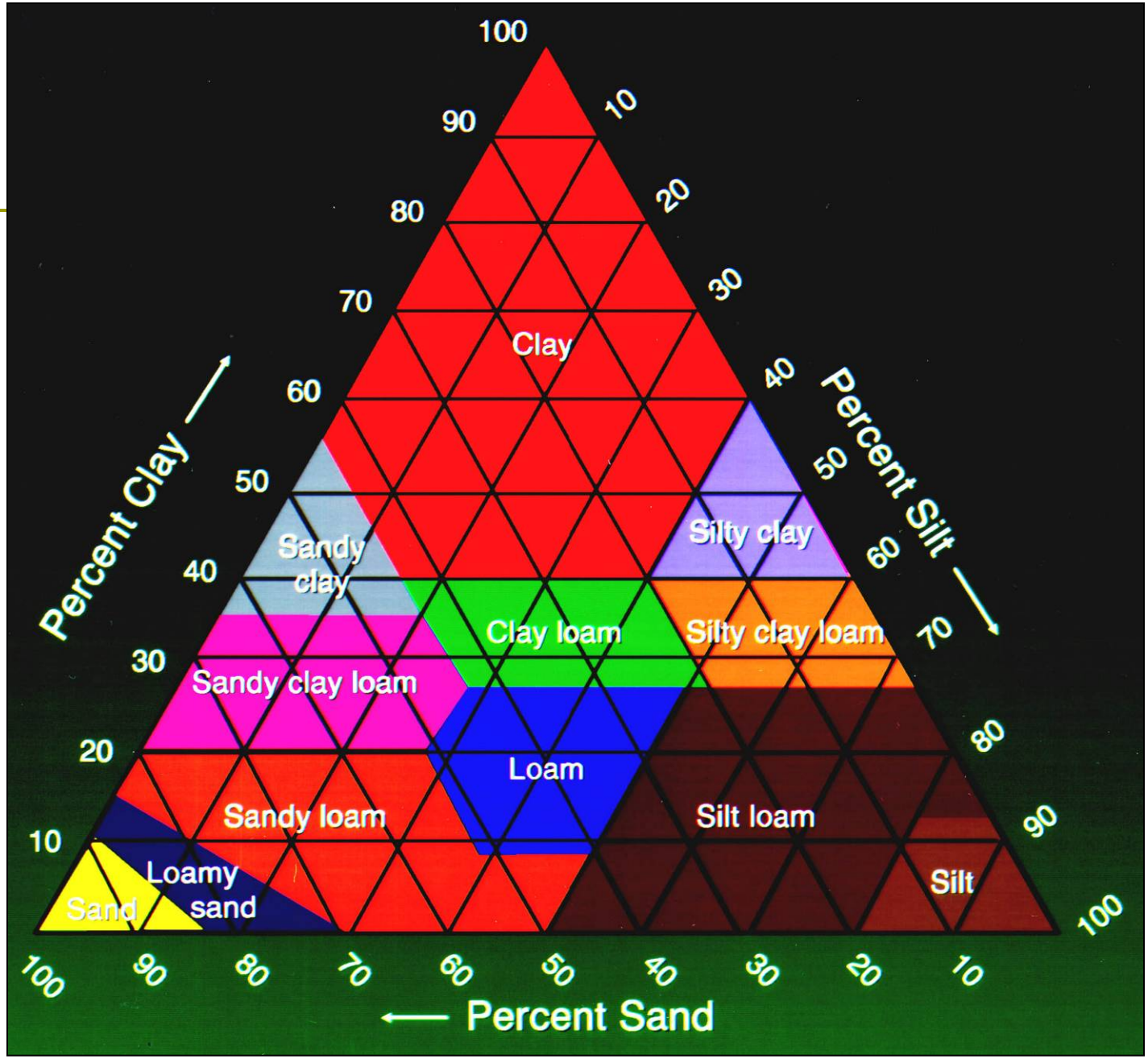


Silt
(feels floury)
(0.05 - 0.002 mm)

dime

Clay
(feels sticky)
(< 0.002 mm)

USDA Soil Texture Triangle

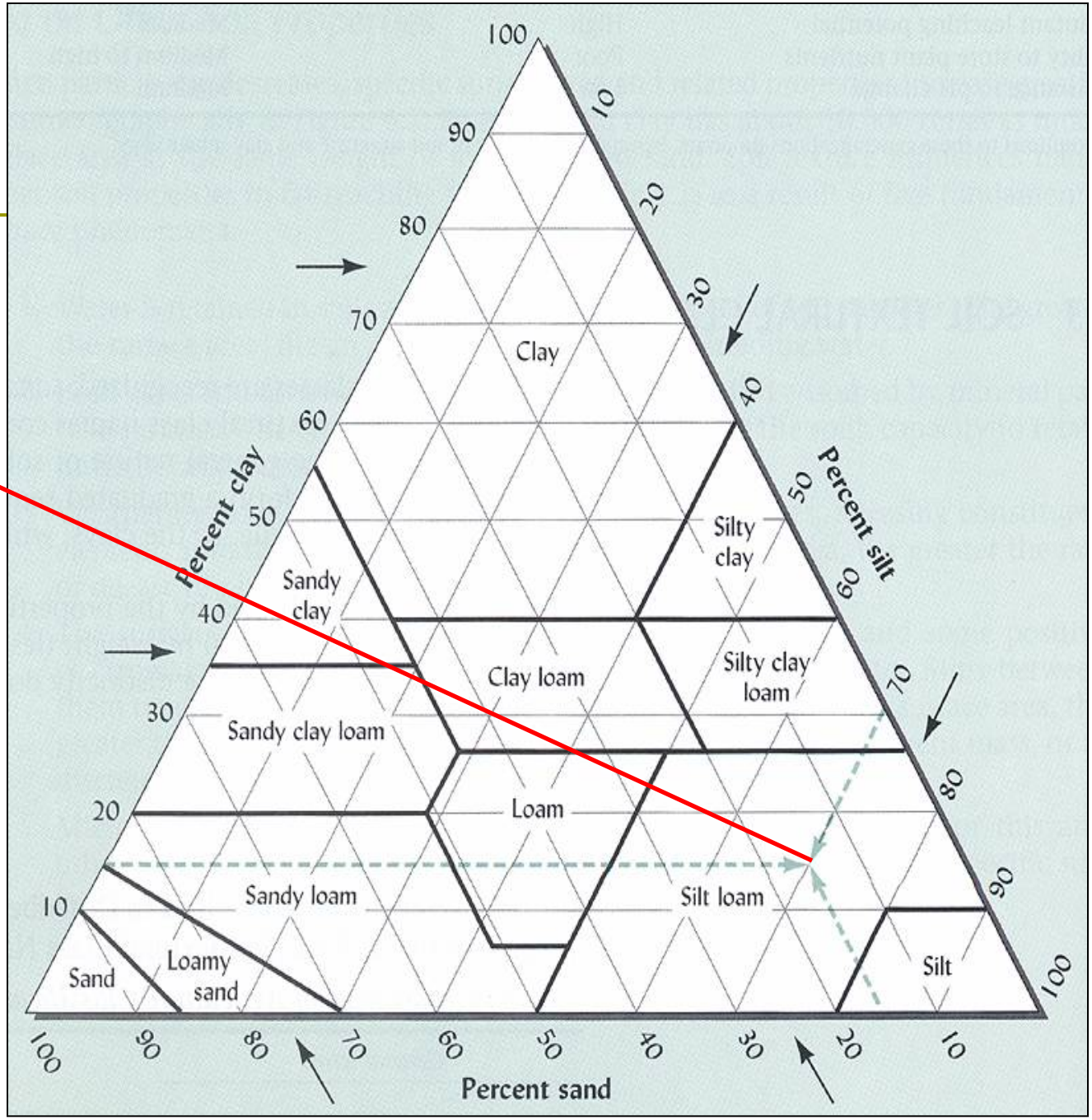


USDA Textural Triangle

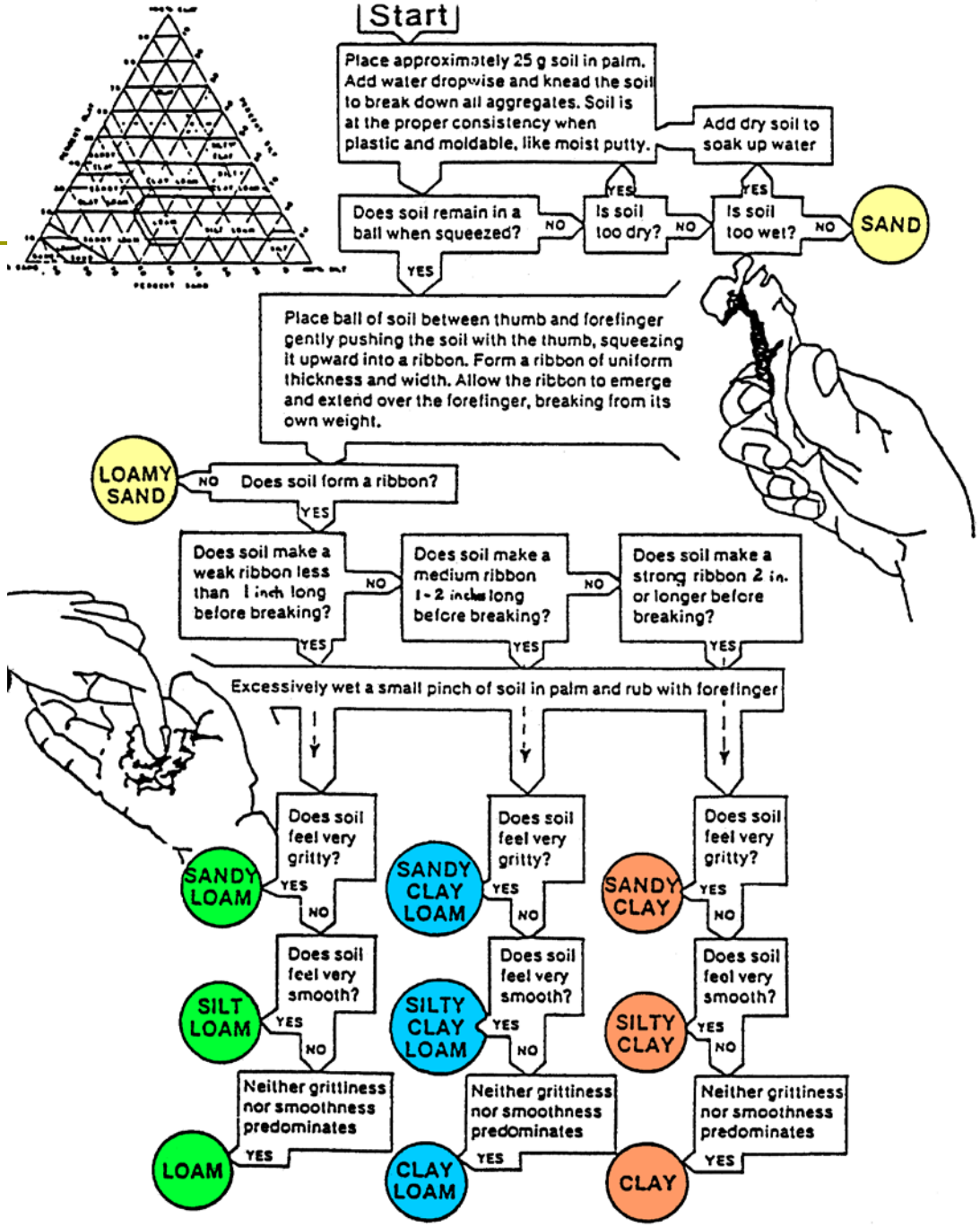
In this example there is

15% clay
15% sand
70% silt

USDA texture = silt loam



Texture Flowchart



Soil Structure

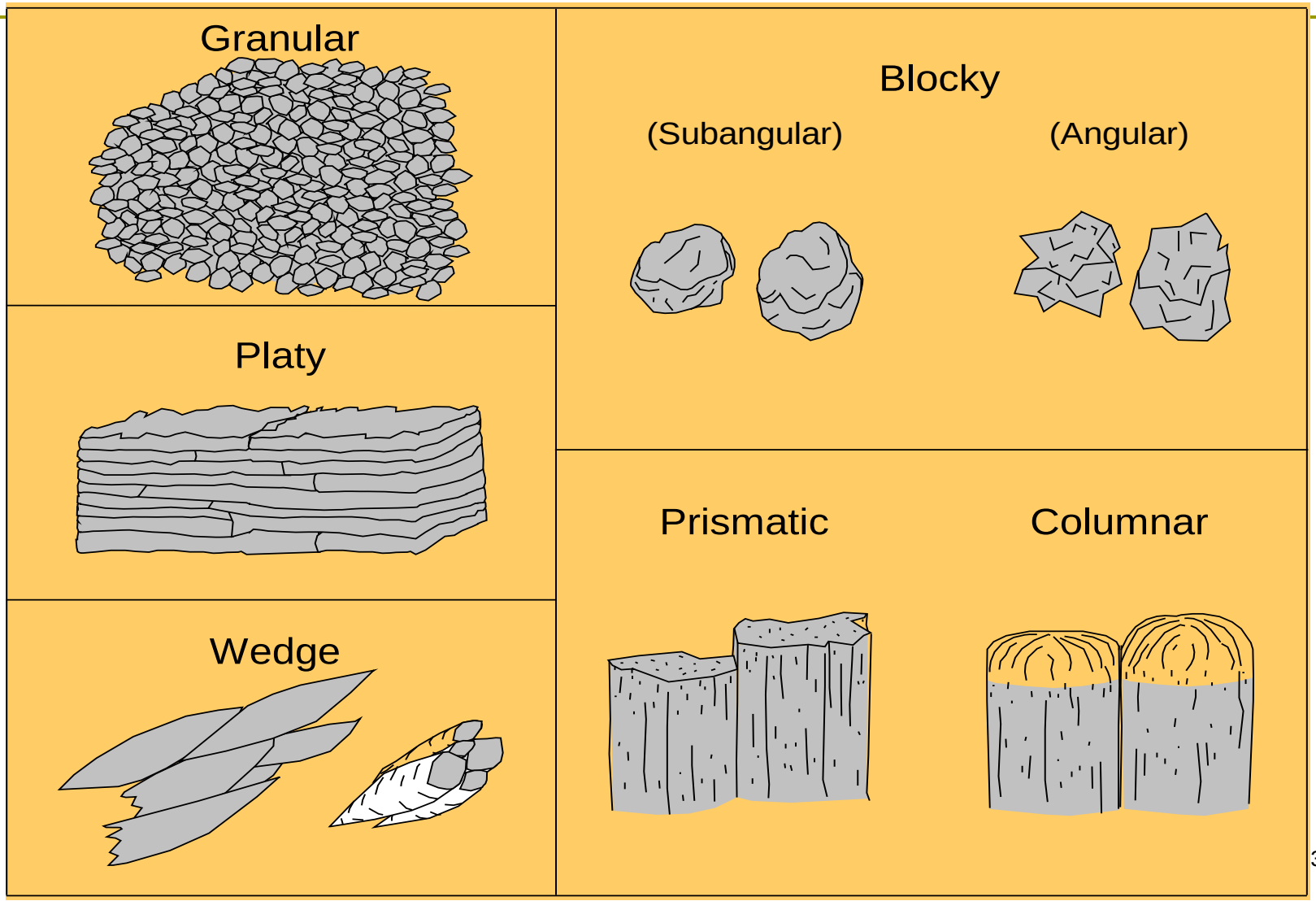
- The combination or arrangement of primary soil particles into secondary units or peds.

- Peds are natural soil aggregates, in contrast to clods or fragments that are formed by tillage or other human activities.

Factors that Affect Soil Structure

- Kind of clay
- Amount of organic matter
- Freezing and thawing
- Wetting and drying
- Action of burrowing organisms
- Growth of root systems of plants

Examples of Soil Structure

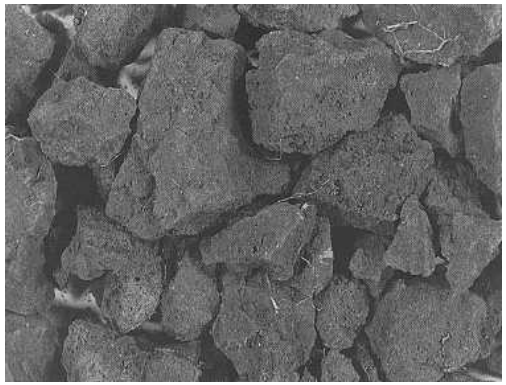


Granular Structure

- Most common in A horizons high in organic matter content
- Microorganisms excrete lignin (“glue”) from humus to bind particles together
- Commonly influenced by soil management

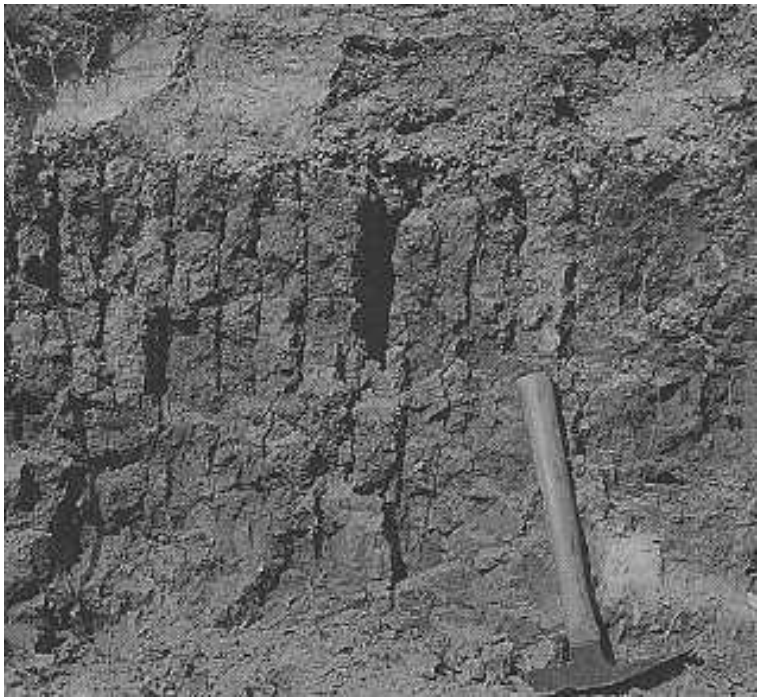
Angular blocky soil structure

Blocky (ABK or SBK)



- common in B horizons, particularly in humid regions
  - ABK (angular)
    - more common in soils higher in smectite
  - SBK (less angular)
    - more common in soils higher in kaolinite
- *up to a point, the more shrinking and swelling, the more angular the structure (PJT theory)*

Prismatic (PR)



- most common in clayey subsoils
- height of ped is greater than width of ped; angular tops

Columnar (COL)

- similar to prismatic except has rounded tops
- found in soils high in Na (sodium)

Platy (PL)

- width is wider than height
- commonly found in compacted soil horizons
  - natural compaction
    - fragipans
    - dense basal till
  - artificial compaction
    - plow plans

Structureless

single grain (SG)

massive (MA)

Saturated Hydraulic Conductivity Ksat

- Is the amount of water that would move vertically through a unit area of saturated soil in unit time under unit hydraulic gradient
- Estimated property, though it can be measured in the field

Saturated hydraulic conductivity

- Replaces use of permeability in soil survey to measure movement of water through the soil

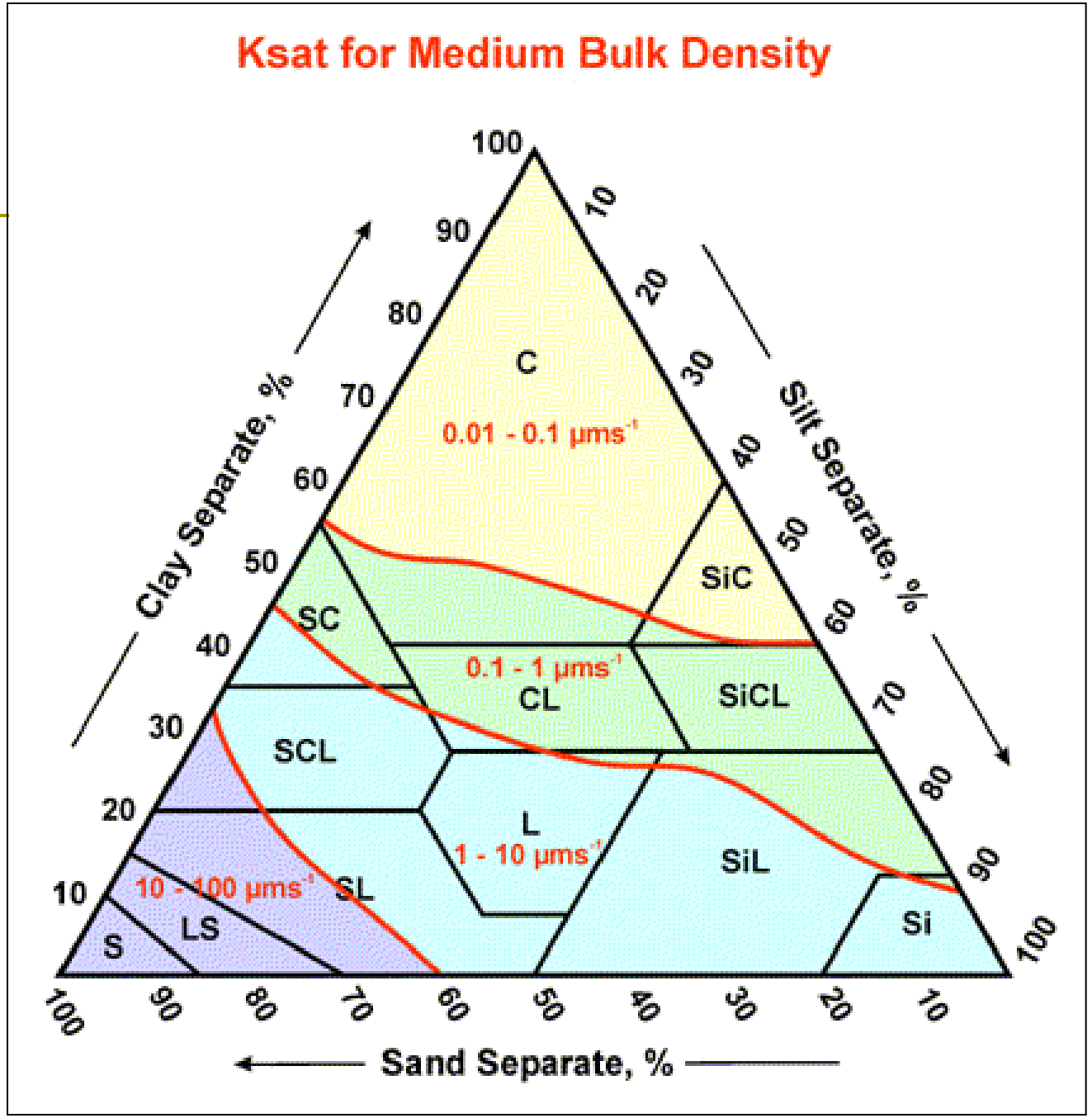
- The soil properties that affect saturated hydraulic conductivity are distribution, continuity, size, and shape of pores, which are not readily observable or measureable

Saturated hydraulic conductivity

- Texture, structure, pore size, density, organic matter, and mineralogy are observable properties related to pore geometry and are used to estimate Ksat

- In making estimates, the soil characteristic that exerts the greatest control for many soils is texture.

Guide for estimating saturated hydraulic conductivity (Ksat) from soil texture.



National Soil Survey Handbook – Exhibit 618-9

Ksat Classes Used in Web Soil Survey

- micrometers per second
  - Very low: 0.00 - 0.01
  - Low: 0.01 - 0.1
  - Moderately low: 0.1 - 1.0
  - Moderately high: 1 – 10
  - High: 10 – 100
  - Very high: 100 - 705

Available Water Capacity

- Amount of water that a soil can store that is available for use by plants
- Affected by:
  - Texture
  - Organic matter
  - Rock fragments
  - Bulk density

Estimating AWC

- No one method will work for the entire country because of variables found in the soil
- Some variables are properties unique to a region that will affect the ability of the soil to hold water
  - Ash in Northwest; multiply by factor of 1.1 or 1.2
- Also affected by rock fragments
- What to do? Trust the data provided in your soil survey information for your area.

Estimated Available Water Capacity Chart (AWC)

Texture Class	AWC (cm water/cm of soil)		
	Low	***RV***	***High***
Sand	0.02	***0.04***	0.06
Loamy sand	0.06	***0.08***	0.10
Sandy loam	0.10	***0.12***	0.14
Loam	0.15	***0.18***	0.20
Silt loam	0.16	***0.20***	0.24
Sandy clay loam	0.12	***0.15***	0.17
Clay loam	0.15	***0.18***	0.20
Silty clay loam	0.18	***0.20***	0.22
Sandy clay	0.14	***0.16***	0.18
Silty clay	0.14	***0.16***	0.18
Clay	0.12	***0.15***	0.18

Soils and Forest Productivity

- Let's now tie what we know about soils to the productivity of a forest site.

- One way to measure Forest Productivity is to look at what is called Site-Index.

- Site-Index is the average height that the dominant or dominant and co-dominant portion of the even-aged forest stand will have at a specific age. Usually 50 years in the eastern United States.

- A tree that is 50 years old and has a height of 70 feet would have a SI of 70.
- Same species and age tree at a different site is only 40 feet in height the SI is 40.
- Which site is more productive?

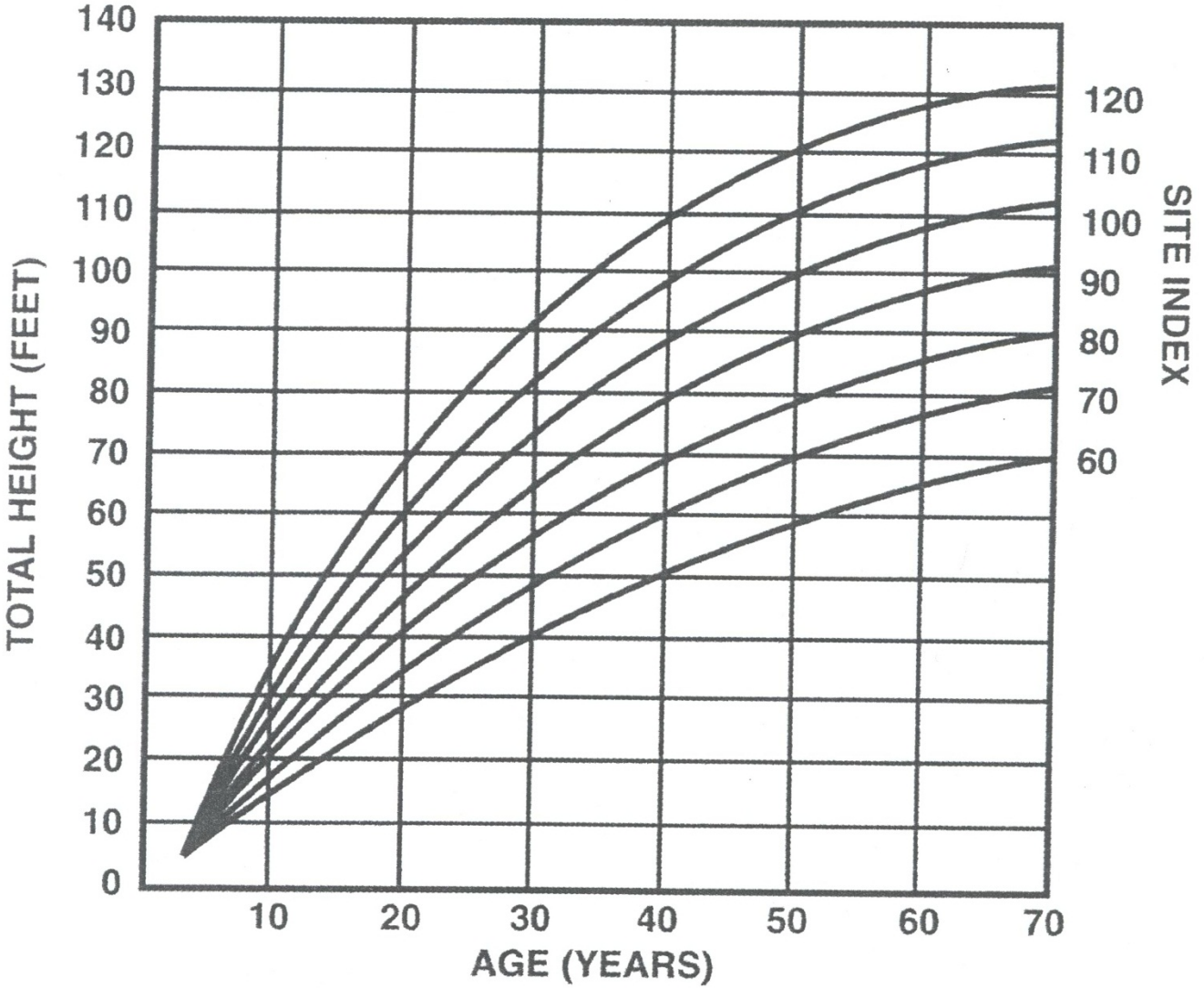
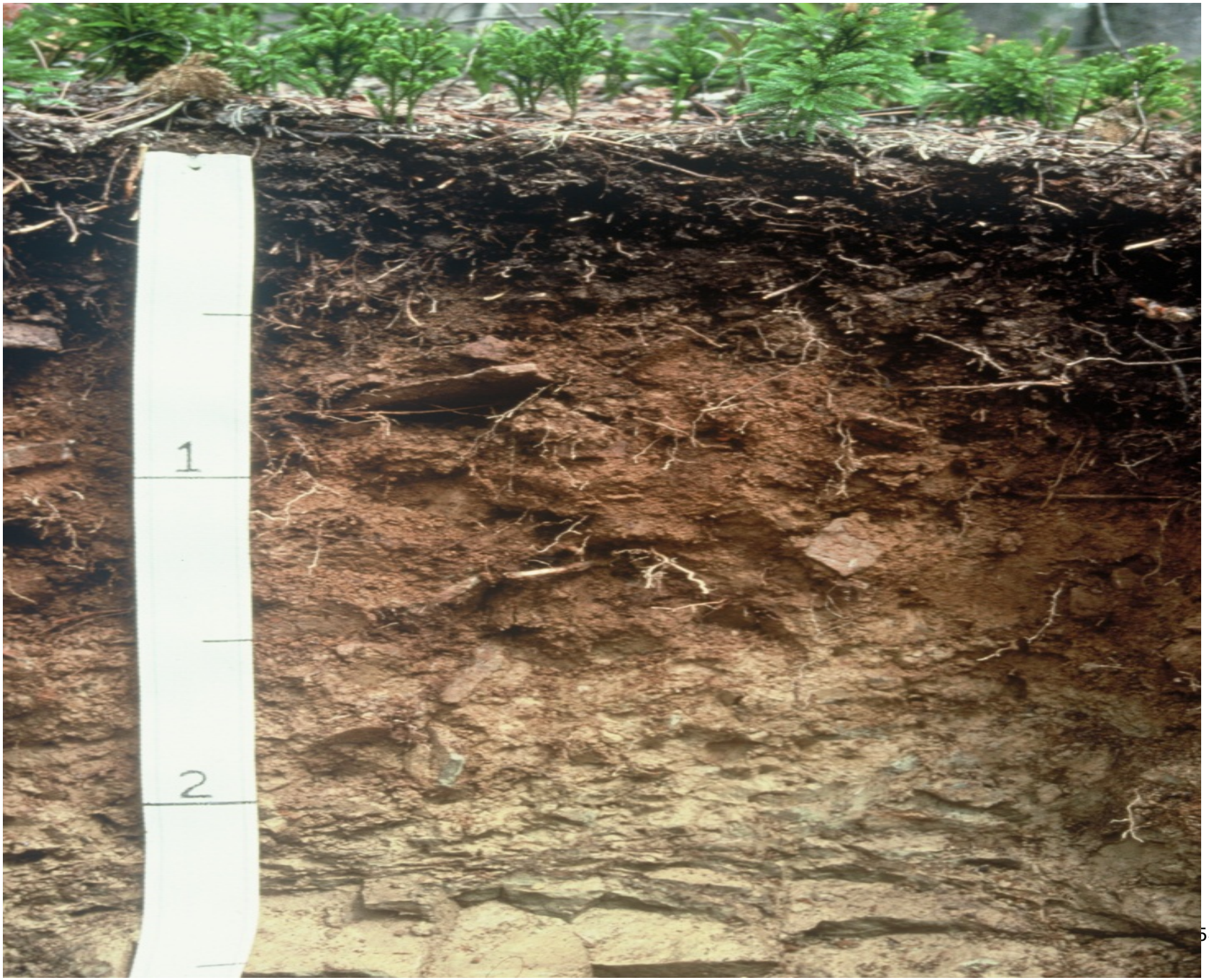


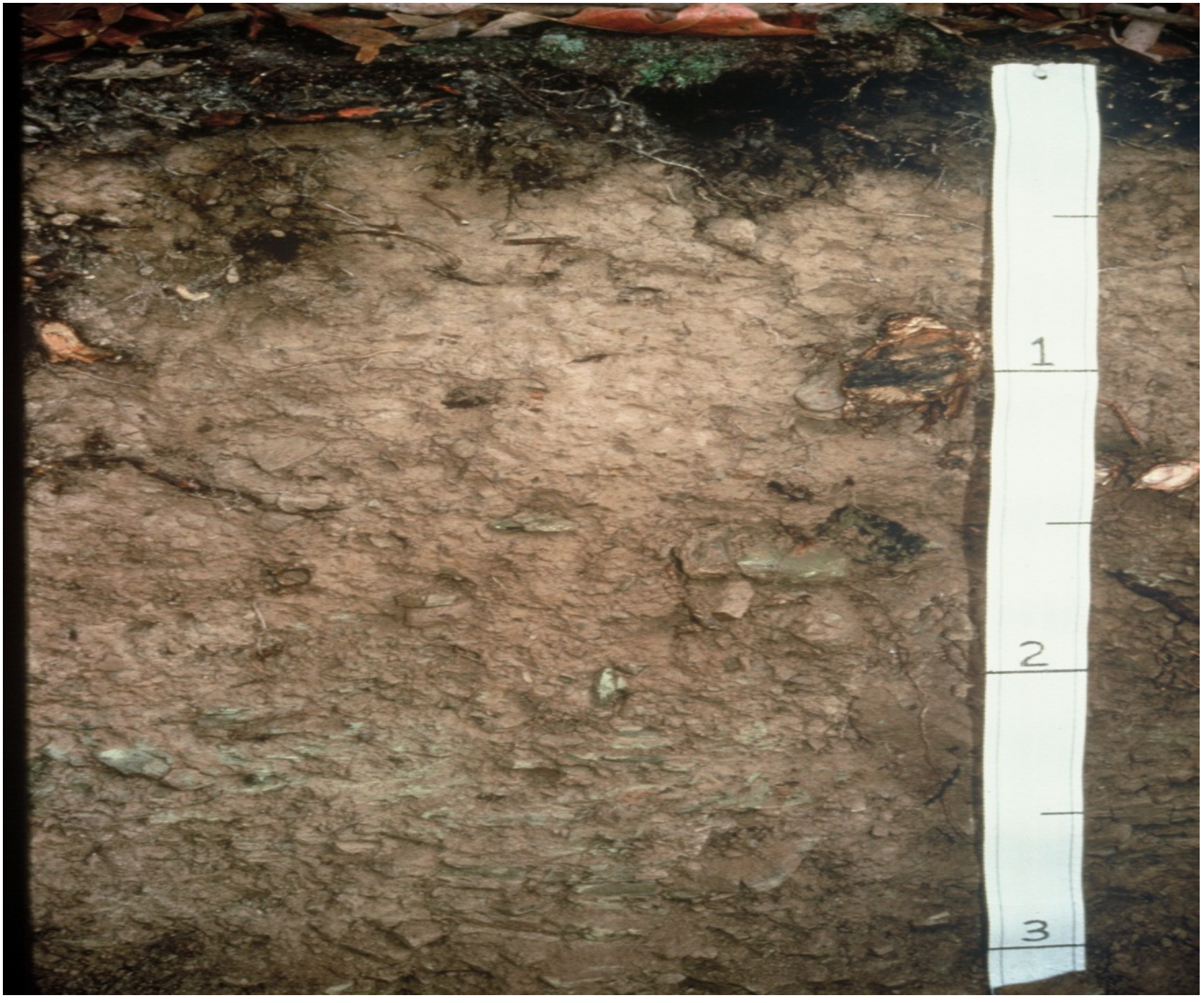
Figure 1. Site index curves for loblolly pine at index age 50 years in the Coastal Plain of Virginia, North Carolina, and South Carolina. (These curves are based on stem analysis of 40 dominant trees in the middle and lower Coastal Plain.)

Table 9.--Woodland Productivity--Continued

Soil name and map symbol	Ordination symbol*	Potential productivity		Average annual growth in**		
		Commonly grown trees	Site index	Cubic feet per acre	Board feet per acre	Cords per acre
CdF***:						
Calvin---	4R	Northern red oak---	70	52	180	0.67
(north aspect)		White oak---	70	52	180	0.67
		Hickory---	---	---	---	---
		Red maple---	---	---	---	---
		Black locust---	---	---	---	---
Dekalb---	3R	Northern red oak---	60	43	110	0.52
(north aspect)		White oak---	60	43	110	0.52
		Hickory---	---	---	---	---
		Red maple---	---	---	---	---
Berks---	3R	Northern red oak---	65	48	145	0.60
(north aspect)		White oak---	65	48	145	0.60
		Eastern white pine--	70	---	---	---
		Red maple---	---	---	---	---
CdF***:						
Calvin---	3R	Northern red oak---	60	43	110	0.52
(south aspect)		White oak---	60	43	110	0.52
		Hickory---	---	---	---	---
		Pitch pine---	---	---	---	---
Dekalb---	2R	Northern red oak---	50	34	60	0.38
(south aspect)		White oak---	50	34	60	0.38
		Chestnut oak---	50	34	60	0.38
		Pitch pine---	---	---	---	---
Berks---	3R	Northern red oak---	55	38	85	0.45
(south aspect)		White oak---	55	38	85	0.45
		Chestnut oak---	55	38	85	0.45
		Pitch pine---	---	---	---	---
CeB---	4A	Northern red oak---	80	62	250	0.81
Cateache		Black cherry---	80	50	---	---
		Cucumbertree---	80	---	---	---
		American beech---	---	---	---	---
		Sugar maple---	80	50	---	---
CeC---	4A	Northern red oak---	80	62	250	0.81
Cateache		Black cherry---	80	50	---	---
		Cucumbertree---	80	---	---	---
		American beech---	---	---	---	---
		Sugar maple---	80	50	---	---
CeD---	4R	Northern red oak---	80	62	250	0.81
Cateache		Black cherry---	80	50	---	---
(north aspect)		Cucumbertree---	80	---	---	---
		American beech---	---	---	---	---
		Sugar maple---	80	50	---	---
CeD---	4R	Northern red oak---	70	52	180	0.67
Cateache		Black cherry---	70	43	---	---
(south aspect)		Cucumbertree---	70	---	---	---
		American beech---	---	---	---	---
		Sugar maple---	70	43	---	---

See footnotes at end of table.


1
2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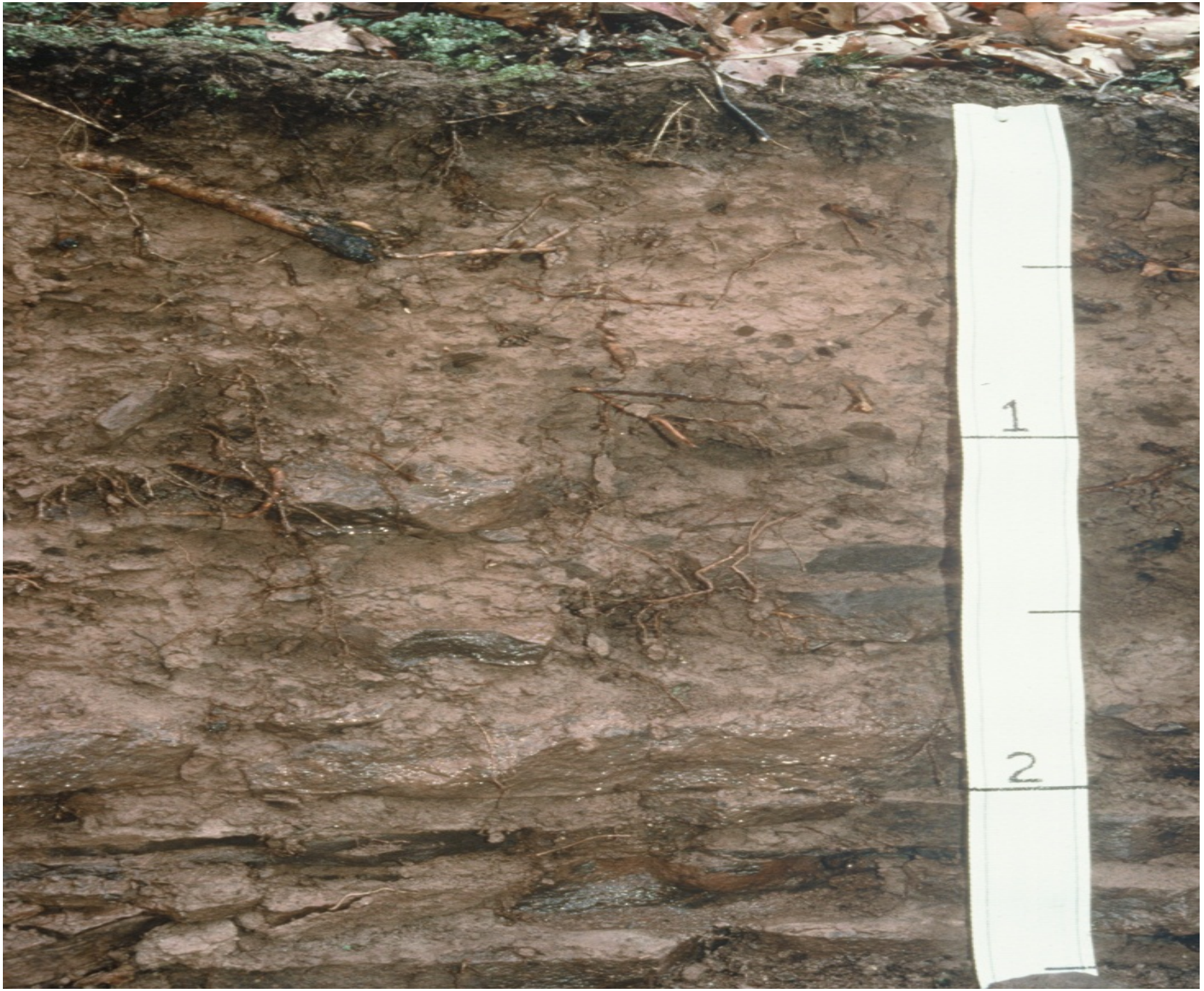
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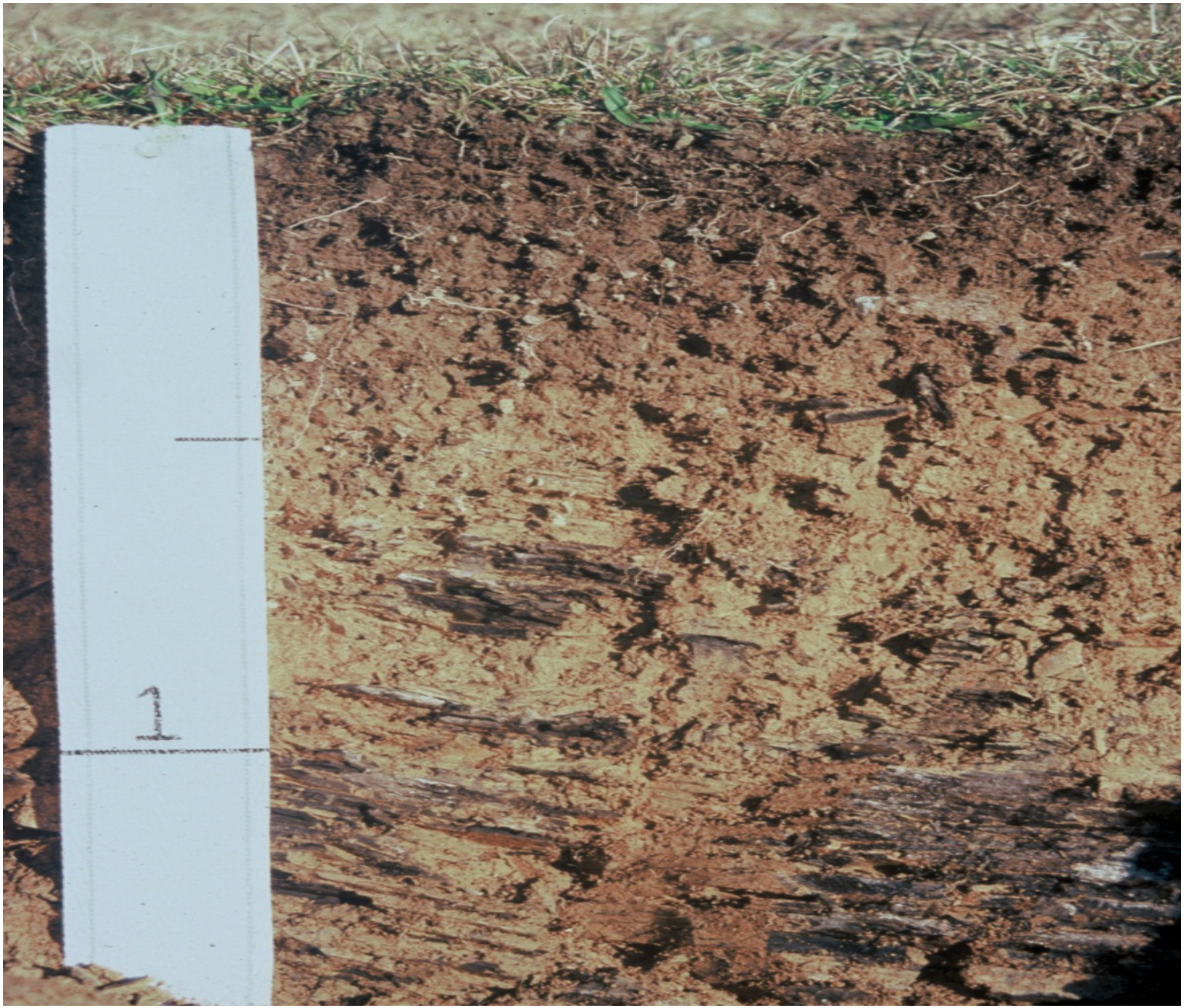


1
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6


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1
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5


1
2


2
3

Table 8.--Woodland Management--Continued

Soil name and map symbol	Erosion hazard*	Seedling mortality*	Plant competition*	Haul roads and skid roads**	Log landings**	Operability of equipment in logging areas**
CdE***:						
Calvin (north aspect)	Moderate: slope.	Moderate: rock fragments.	Moderate: high productivity.	Moderate: slope, low strength.	Severe: slope.	Moderate: slope.
Dekalb (north aspect)	Moderate: slope.	Moderate: rock fragments.	Slight	Moderate: slope, depth to rock.	Severe: slope.	Moderate: slope.
Berks (north aspect)	Moderate: slope.	Moderate: rock fragments.	Slight	Moderate: slope.	Severe: slope.	Moderate: slope.
CdE***:						
Calvin (south aspect)	Moderate: slope.	Moderate: rock fragments, slope.	Slight	Moderate: slope, low strength.	Severe: slope.	Moderate: slope.
Dekalb (south aspect)	Moderate: slope.	Moderate: rock fragments, slope.	Slight	Moderate: slope, depth to rock.	Severe: slope.	Moderate: slope.
Berks (south aspect)	Moderate: slope.	Moderate: rock fragments, slope.	Slight	Moderate: slope.	Severe: slope.	Moderate: slope.
CdF***:						
Calvin (north aspect)	Severe: slope.	Moderate: rock fragments.	Moderate: high productivity.	Severe: slope.	Severe: slope.	Severe: slope.
Dekalb (north aspect)	Severe: slope.	Moderate: rock fragments.	Slight	Severe: slope.	Severe: slope.	Severe: slope.
Berks (north aspect)	Severe: slope.	Moderate: rock fragments.	Slight	Severe: slope.	Severe: slope.	Severe: slope.
CdF***:						
Calvin (south aspect)	Severe: slope.	Moderate: rock fragments, slope.	Slight	Severe: slope.	Severe: slope.	Severe: slope.
Dekalb (south aspect)	Severe: slope.	Moderate: rock fragments, slope.	Slight	Severe: slope.	Severe: slope.	Severe: slope.
Berks (south aspect)	Severe: slope.	Moderate: rock fragments, slope.	Slight	Severe: slope.	Severe: slope.	Severe: slope.
CeB---- Cateache	Slight	Slight	Moderate: high productivity.	Moderate: low strength.	Moderate: low strength.	Slight.

See footnotes at end of table.

Summary

- Soils are an important component of the forest ecosystem.
- Soils influence the productivity of the forest site.
- Soils influence how the forest should be managed to maintain productivity.
- Soils are an integral component of many of natures cycles, in particular the water, the carbon and the nitrogen cycles.

SO DON'T TREAT YOUR

SOILS

LIKE DIRT

QUESTIONS?