USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

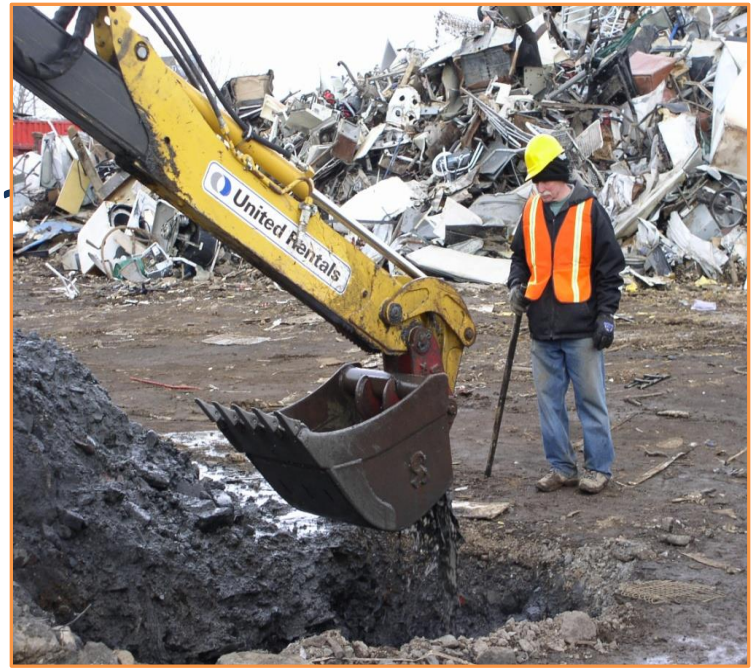
Susquehanna County Conservation District
Conserving Natural Resources for Our Future

USDA-Natural Resource Conservation Service
&
Susquehanna County Conservation District

2021 Envirothon Soils Training

Topics of Discussion

- Part 1: **What is Soil?**
- Part 2: **Why is Soil Important?**
- Part 3: **Soil Formation**
- Part 4: **Soil Properties**
- Part 5: **Soil Surveys**



1. What is Soil?

- **mixture of mineral and organic materials**
- **forms on the surface of the earth**
- **changes in response to climate and organisms**

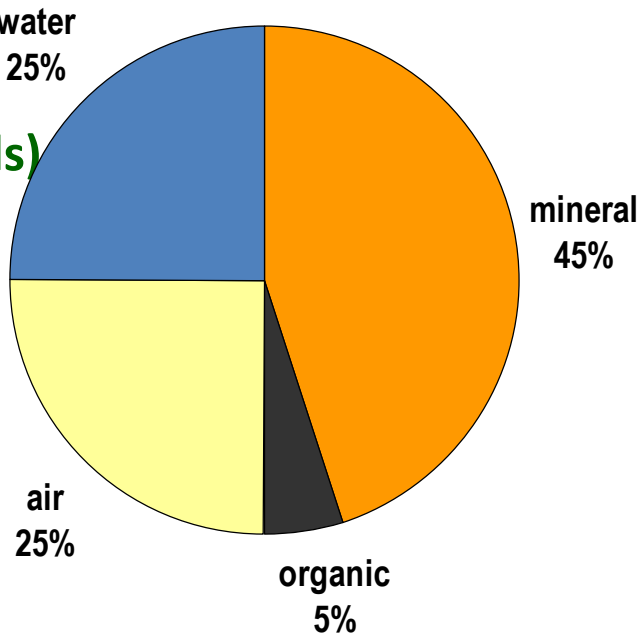
Soil Components

Solid space

- mineral material (from rocks)
  - sand, silt & clay sized particles
- organic material (from plants & animals)
  - various stages of decomposition

Pore space

- air
- water



An ideal agricultural soil
50% pore space
50% solid space

Soil Organic Matter

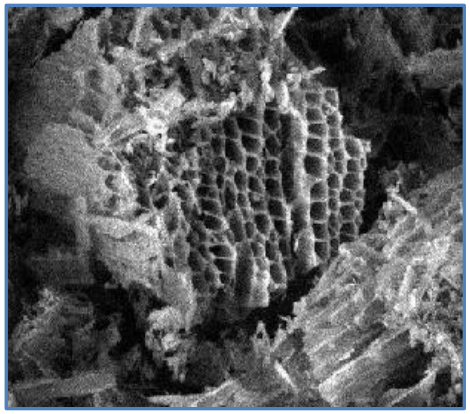
(~60% carbon)

Organic matter from a tidal marsh soil

- **Living**
  - **Microbial biomass**
  - **Roots**
- **Active fraction**
  - **relatively fresh residues**
- **Well decomposed**
  - **humus (stabilized organic matter)**

- **Black Carbon** – byproduct of combustion of fossil fuels (e.g., soot)
  - lower oxygen content (O / C $\leq$ 0.33)
  - common in urban areas
  - highly resistant to biodegradation
  - higher affinity for some contaminants

Soil Organic Matter Properties



Electron microscope photo of SOM

- chemically active
- high surface area
- high water & nutrient holding capacity
- promotes aggregation
- reduces plasticity & cohesion
- supplies nutrients

2. Why should we know our soils?

- ✓ **Soils are essential for a healthy environment**
- ✓ **Soils are <u>variable</u>**
- ✓ **Soils can be <u>degraded</u>**

FUNCTIONS OF SOIL

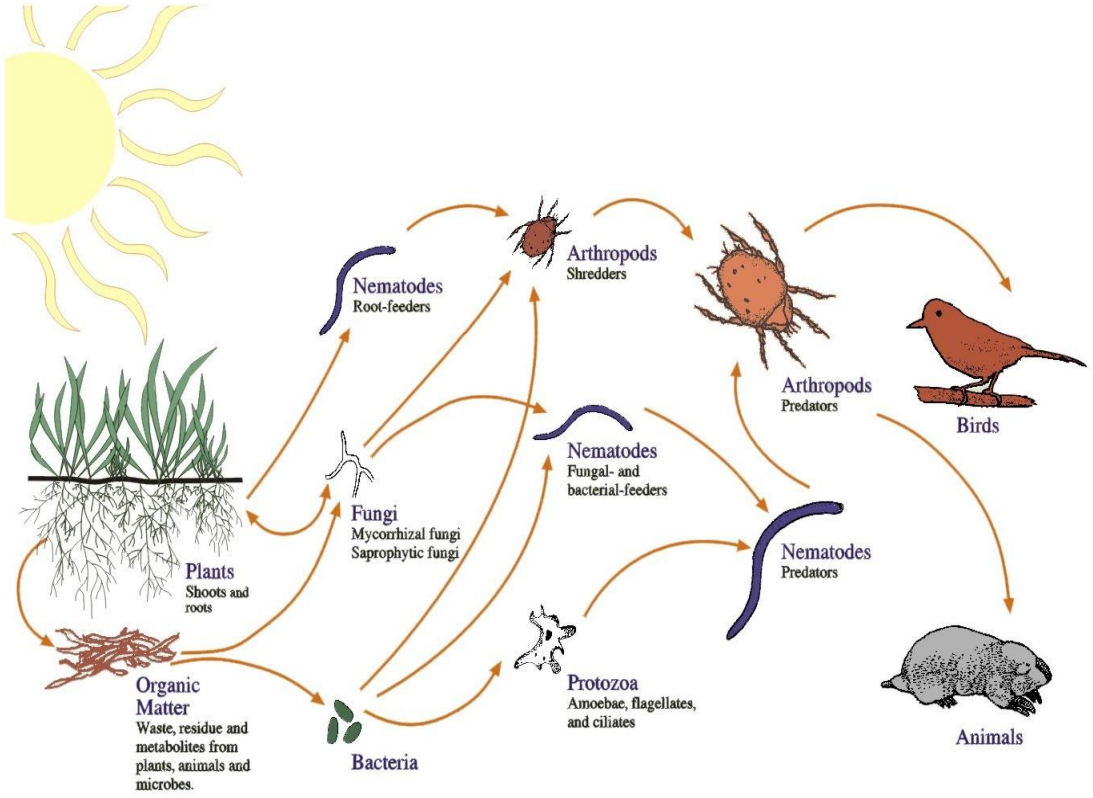
- Regulate water flow
- Filter potential
- pollutants
- Sustains plant life
- **Sustains animal life**
- Cycles and stores
- nutrients – N, C, P

- Waste disposal – sludge applications or home septic systems
- Building materials – brick, adobe
- Recreational activities – sports, camping, gardening

Sustain Biological Activity, Diversity, and Productivity

- The Soil Food Web

- Soil characteristics influence ecosystem characteristics (plants, microbes, insects, animals, etc.)

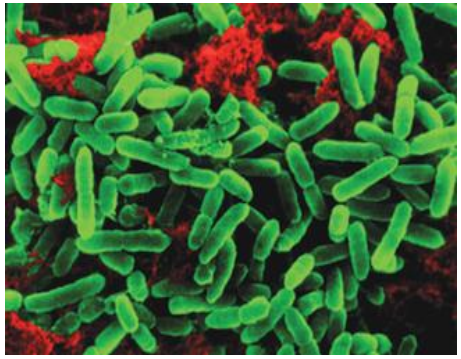


Typical Number of Organisms in Healthy Soil

		Agricultural Soils	Prairie Soils	Forest Soils
Bacteria	**Per Teaspoon of soil (1 gram dry)**	100 million to 1 billion	100 million to 1 billion	100 million to 1 billion
Fungi		Several yards	Tens to hundreds of yards	Several hundred yards in deciduous forests. 1 to 40 **miles** in coniferous forests!
Protozoa		Several thousand flagellates and amoebae, 100 to several hundred ciliates.	Several thousand flagellates and amoebae, 100 to several hundred ciliates.	Several hundred thousand amoebae, fewer flagellates.
Nematodes		10 to 20 bacterial-feeders. A few fungal-feeders. Few predatory nematodes.	10 to several hundreds..	Several hundred bacterial- and fungal-feeders. Many predatory nematodes.
Arthropods	**Per Square Foot**	Up to 100.	500 to 2,000	10,000 to 25,000. Many more species than in agricultural soils
Earthworms		5 to 30. More in soils with high organic matter	10 to 50. Arid or semi-arid areas may have none.	10 to 50 in deciduous woodlands. Very few in coniferous forests.

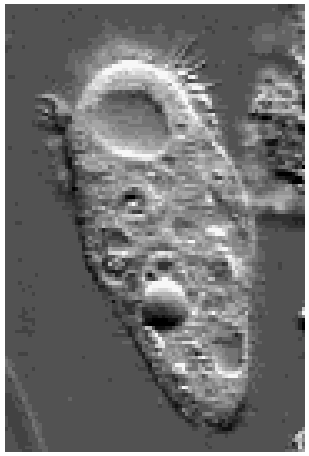
One cup of soil may hold as many bacteria as there are people on Earth.

Soil Organisms



Bacteria

Fungi



Protozoa

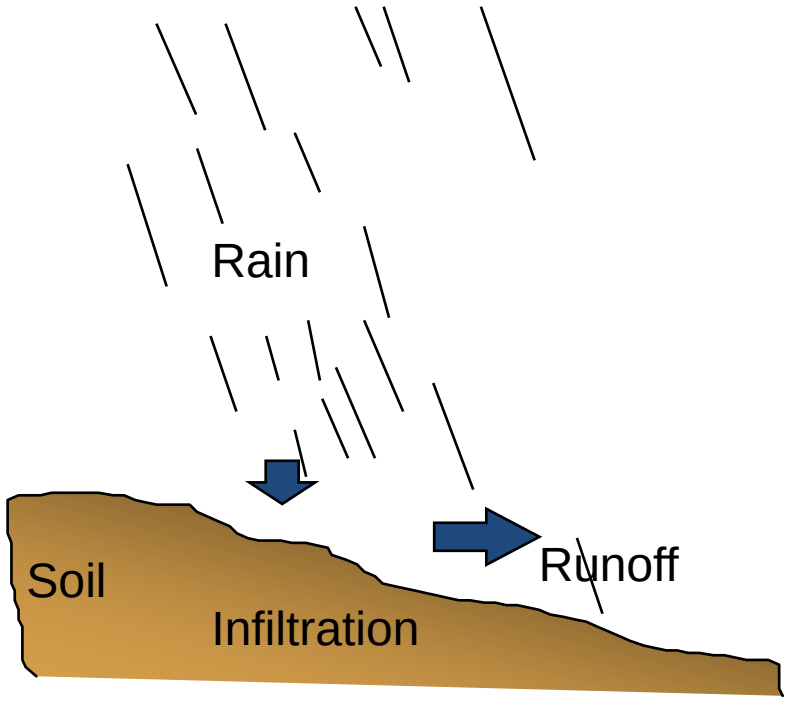
Nematodes

Arthropods

Earthworms

Soil Function…

Controlling water and solute flow



Infiltration – water moves <u>into</u> the soil

- Can be used by plants
- Can recharge groundwater
- Can be evaporated or transpired (cooling effect

Runoff – water moves <u>over</u> soil surface

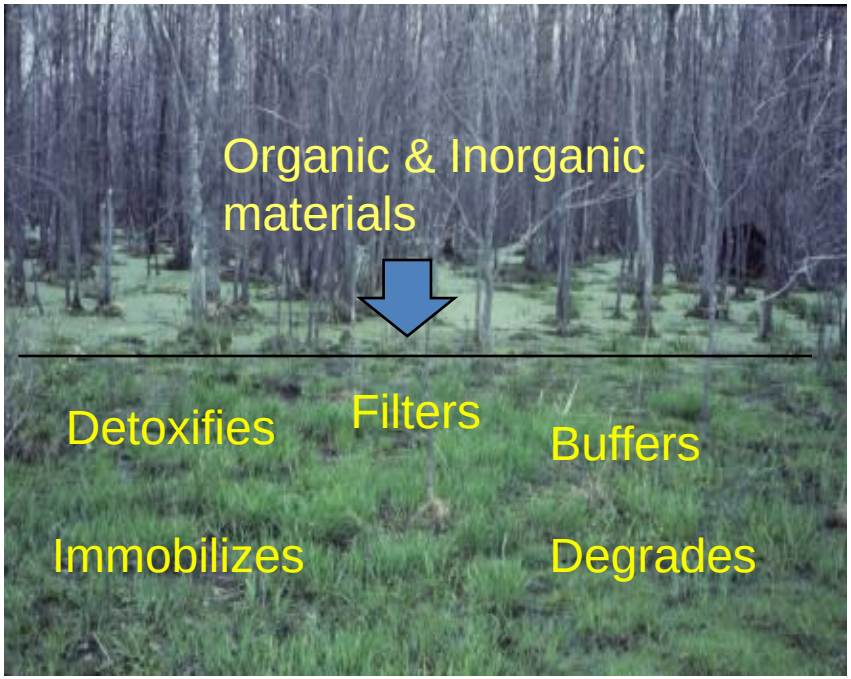
- Can erode soil
- Can pick up pollutants (oil, fertilizers, pesticide
- Can end up in sewer system or in surface water

Important factors

- Rainfall rate
- Slope
- Soil conditions

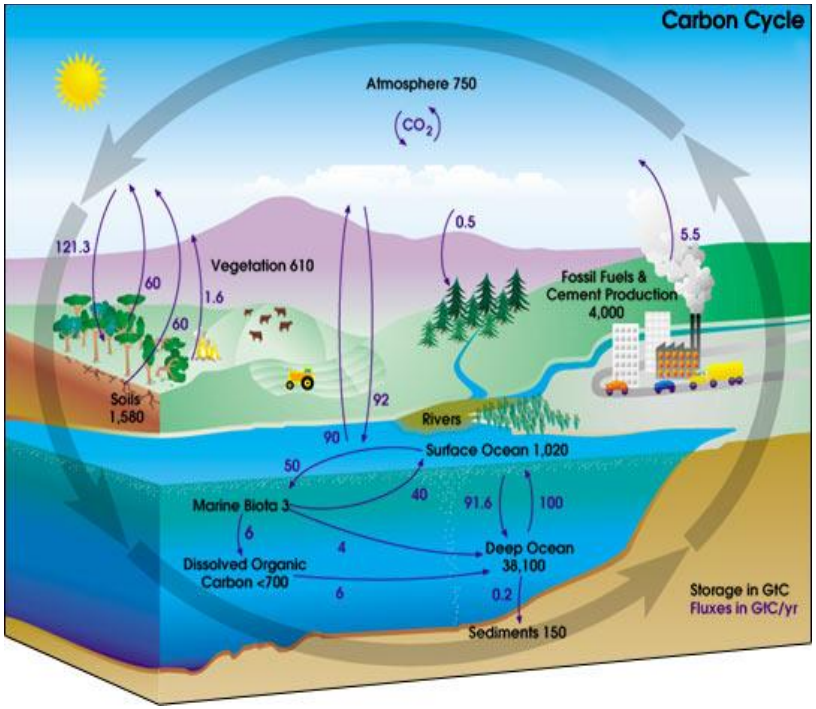
Soil Function…

Filtering and Buffering



Soils can provide physical, biological, and chemical treatment of waste material.

Nutrient cycling



<u>Carbon,</u> nitrogen, phosphorus & other elements are cycled through soils.

Soil Function continued...

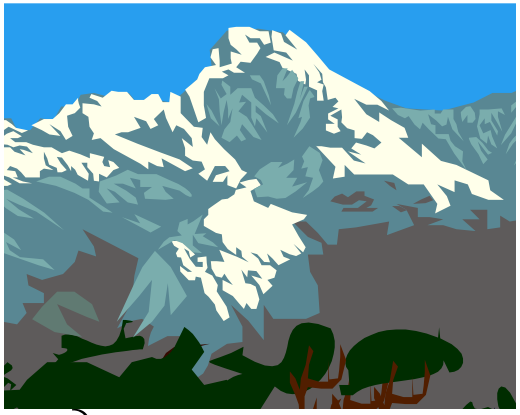
Structural support

5 SOIL FORMING FACTORS

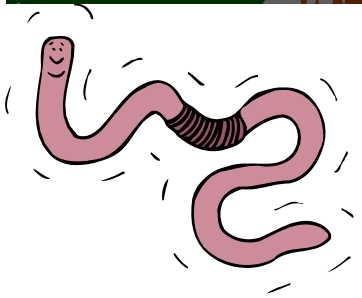
Parent Material

Climate

Topography



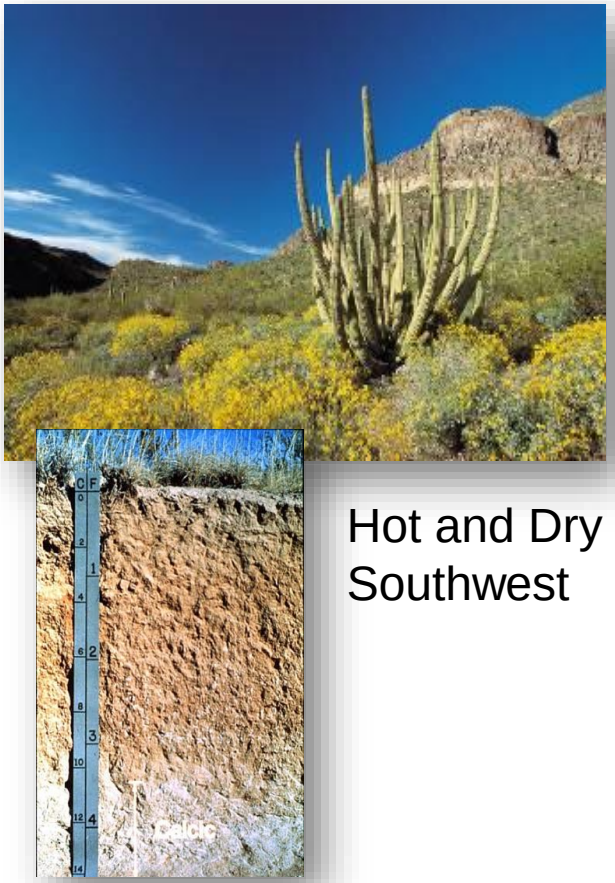
Organisms



Time

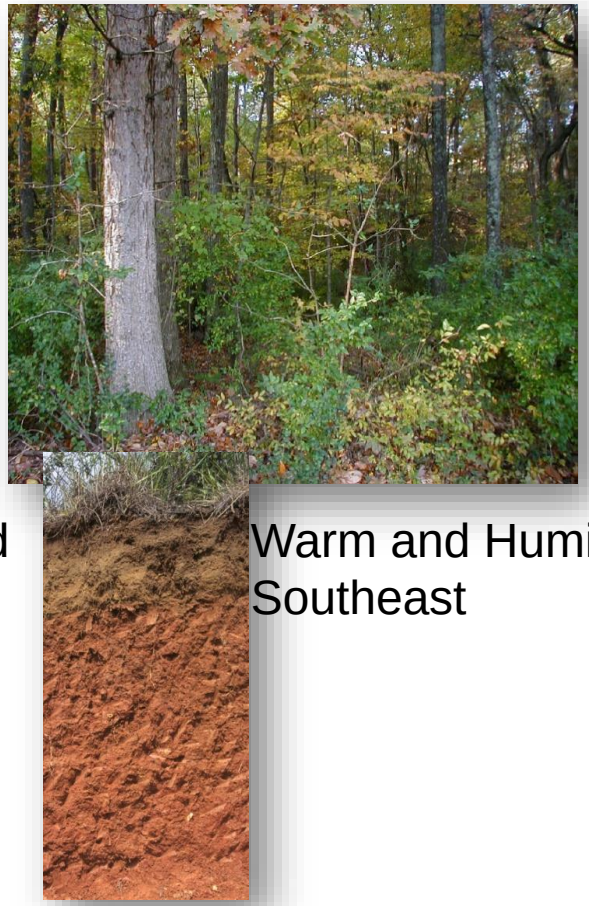
Soil Forming Factors:
Climate

Temperature and Moisture affect soils



Hot and Dry
Southwest

Cool and Humid
New England

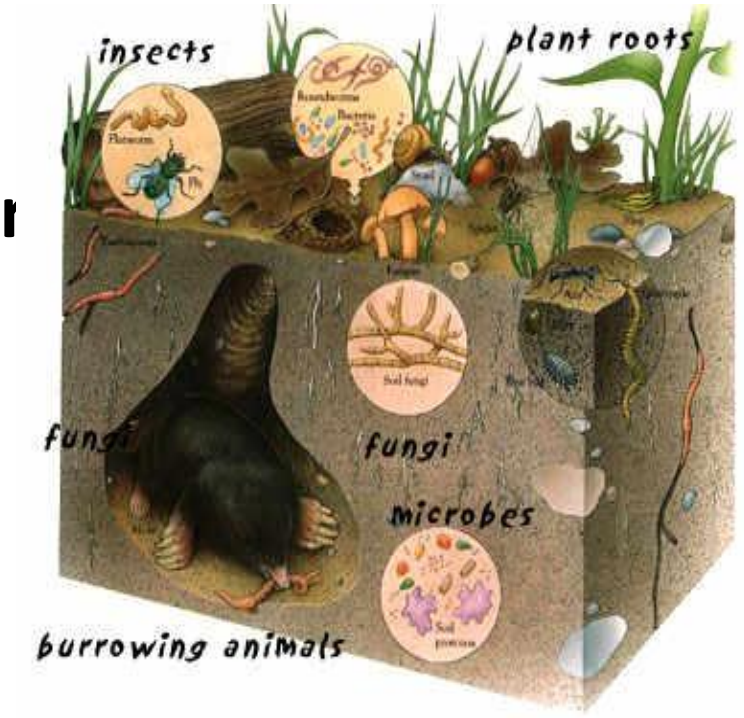


Warm and Humid
Southeast

Soil Forming Factors: Organisms

Animals, plants, insects, microbes, & humans affect s

- **Add organic matter**
- **Break down organic matter**
- **Increase soil porosity**
- **Affect soil chemistry**
- **Disturb soil**

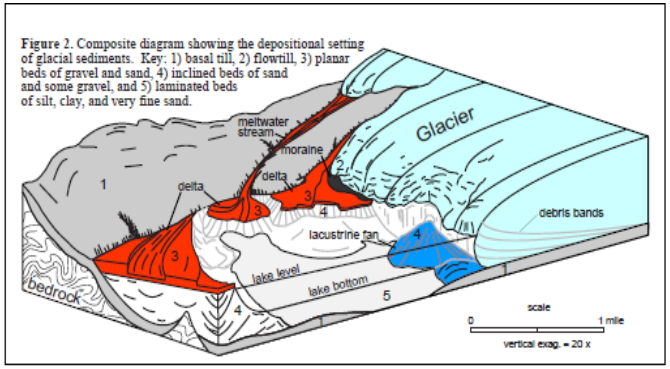


Soil Forming Factors

Parent Material - surficial deposits for soil formation

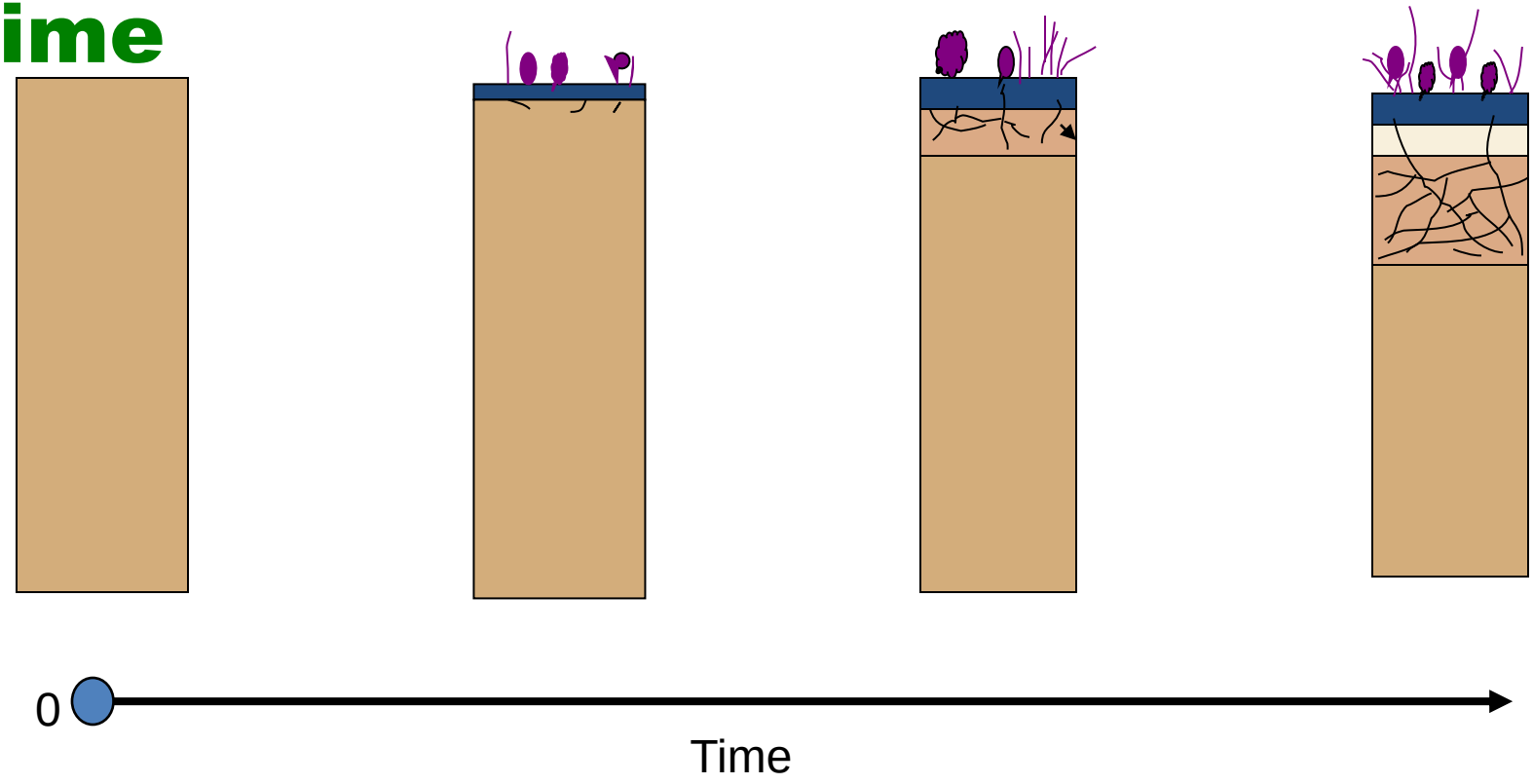
In Susquehanna County:

- **Glacial Till** – material left by the ice sheet ~ **20,000 years ago**
- **Glacial Outwash** – material deposited by glacial meltwater
- **Alluvium** – more recent stream deposits
- **Tidal Marsh** deposits – high in organic matter & silt



- **Fill** – human transported materials - variable

Soil Forming Factors: Time



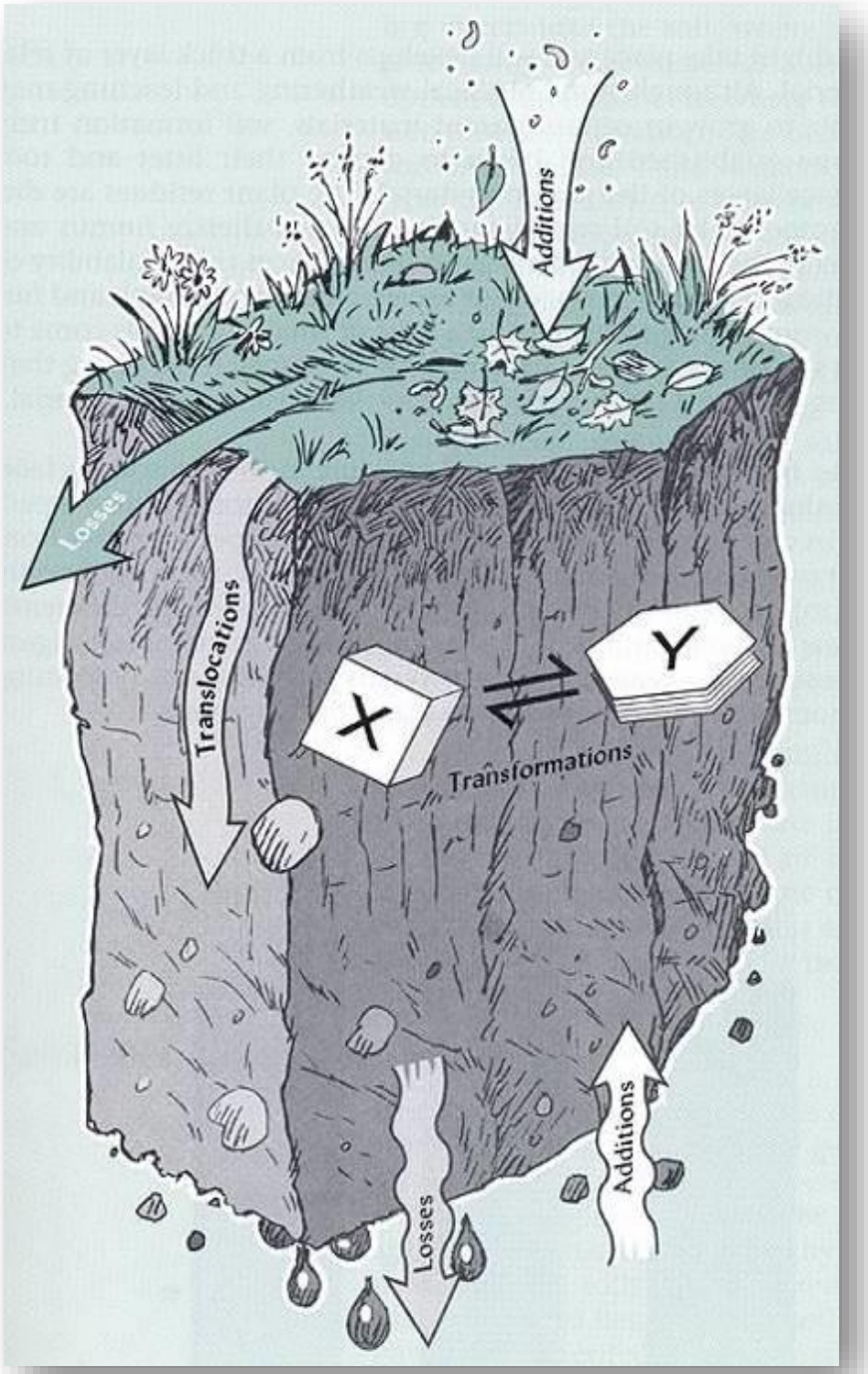
Soils change with time

Soil Forming Processes

(what's going on in the soil)

- **Additions**
- **Losses**
- **Translocations**
- **Transformations**

The balance of these processes varies with the five SF Factors and determines the nature of the soil profile.



4. Soil Properties

- Soil Horizons
- Color
- Texture
- Structure
- Consistence
- pH

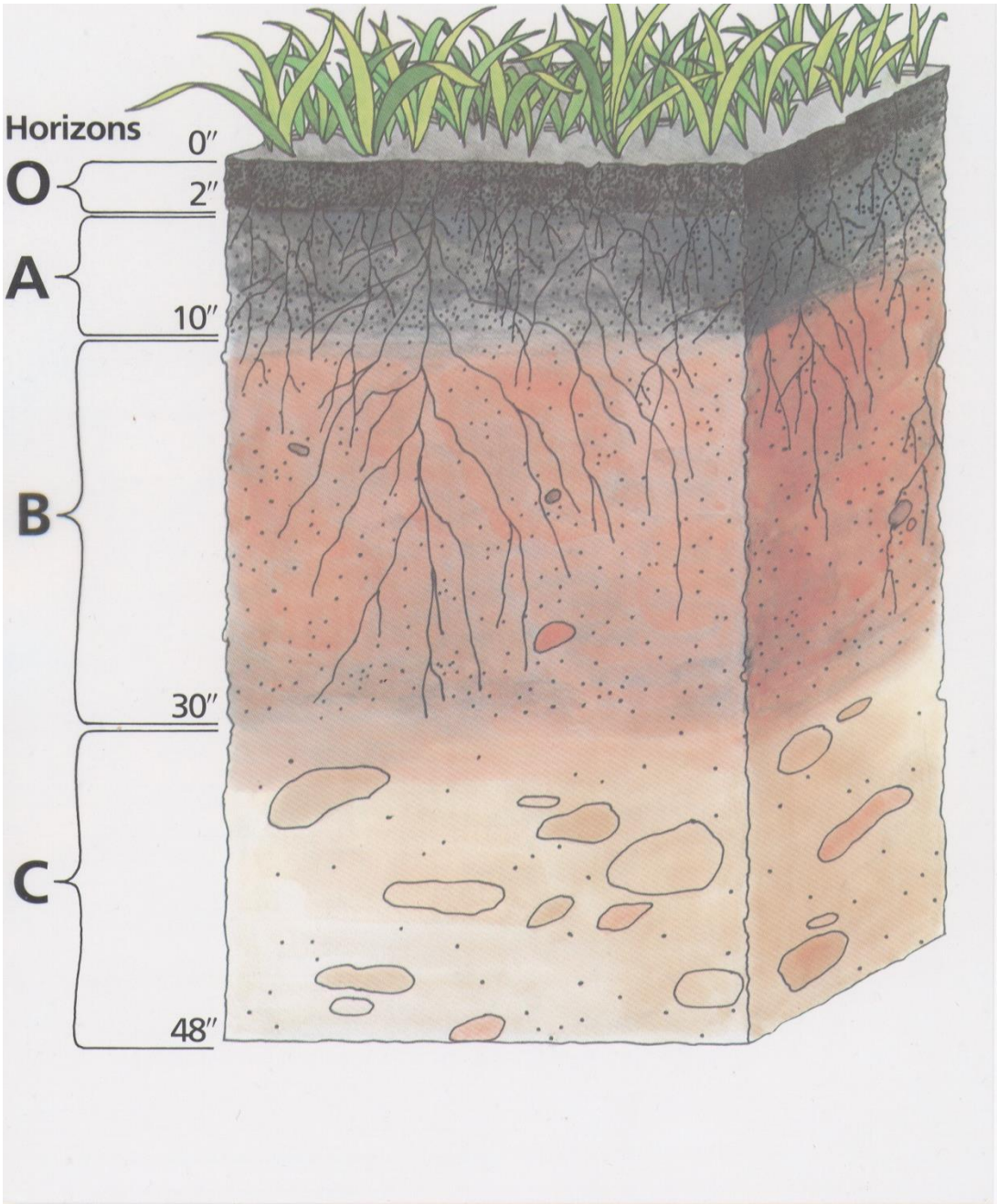
Limerick silt loam, Bronx

Soil Horizons

Layers parallel to the surface

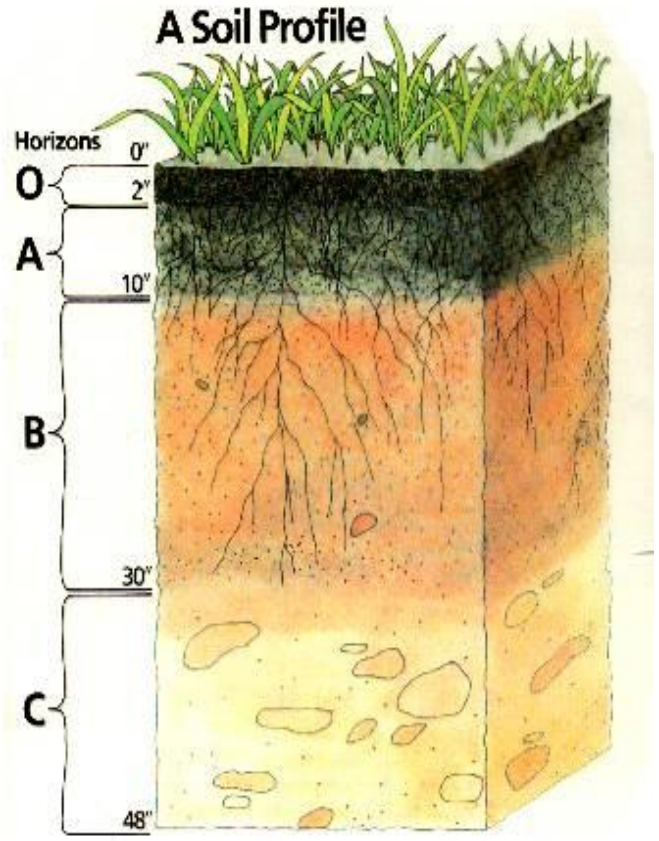
Form as a result of processes

(additions, losses, translocations, transformations)



Soil Horizons

- **O – Dominantly organic material**
- **A - Mineral layer with accumulation of organic matter (topsoil layer)**
- **B - Development of color (from iron) and structure (subsoil layer)**
- **C – Parent material with no evidence of soil forming process**
- **R horizon – bedrock, not shown**



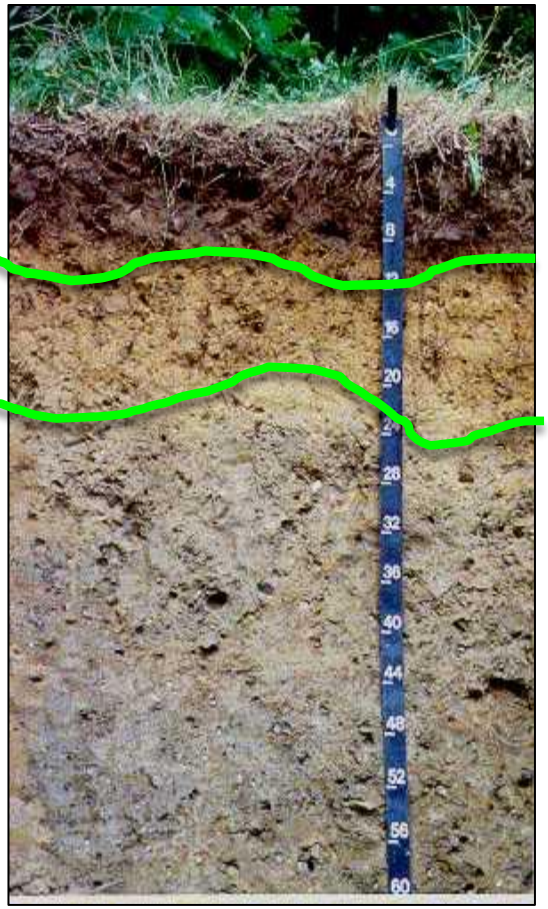
Soil Horizons

Can you describe 3 horizons in this soil?

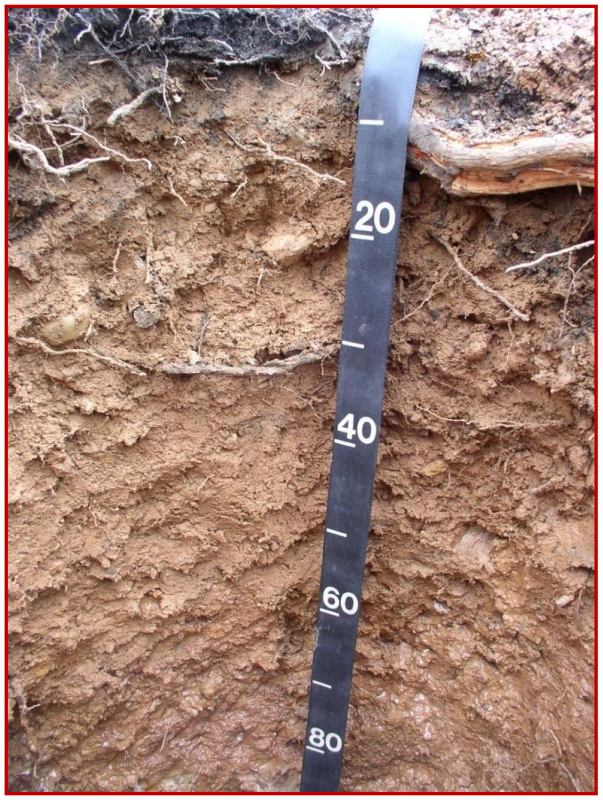
A horizon

B horizon

C horizon



Soil Color



Boonton loam, Staten Island

Important coloring agents in soil:

1) **Organic matter**
   - Darkens the soil (topsoil)

2) **Iron**
   - Brown, red, or yellow iron oxides form in aerated soils
   - Can turn blue or green in saturated soils
   - Gray color remains when iron is removed

Importance of Soil Color

- ✓ **Parent material influence**
  (indicator of source)
- ✓ **Reflects soil forming processes**
- ✓ **Can be used as an indicator of wet soil conditions** (Iron can be removed in anaerobic soils)

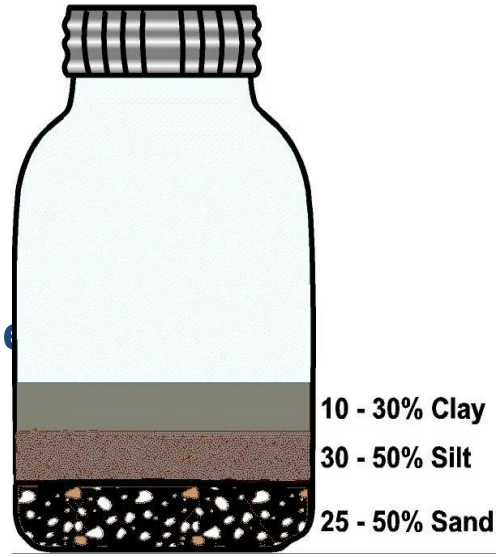
Soil Texture

Relative proportion of sand, silt and clay in a soil

- Important effect on:
  - permeability
  - water & nutrient holding capacity
  - soil suitability for many uses.

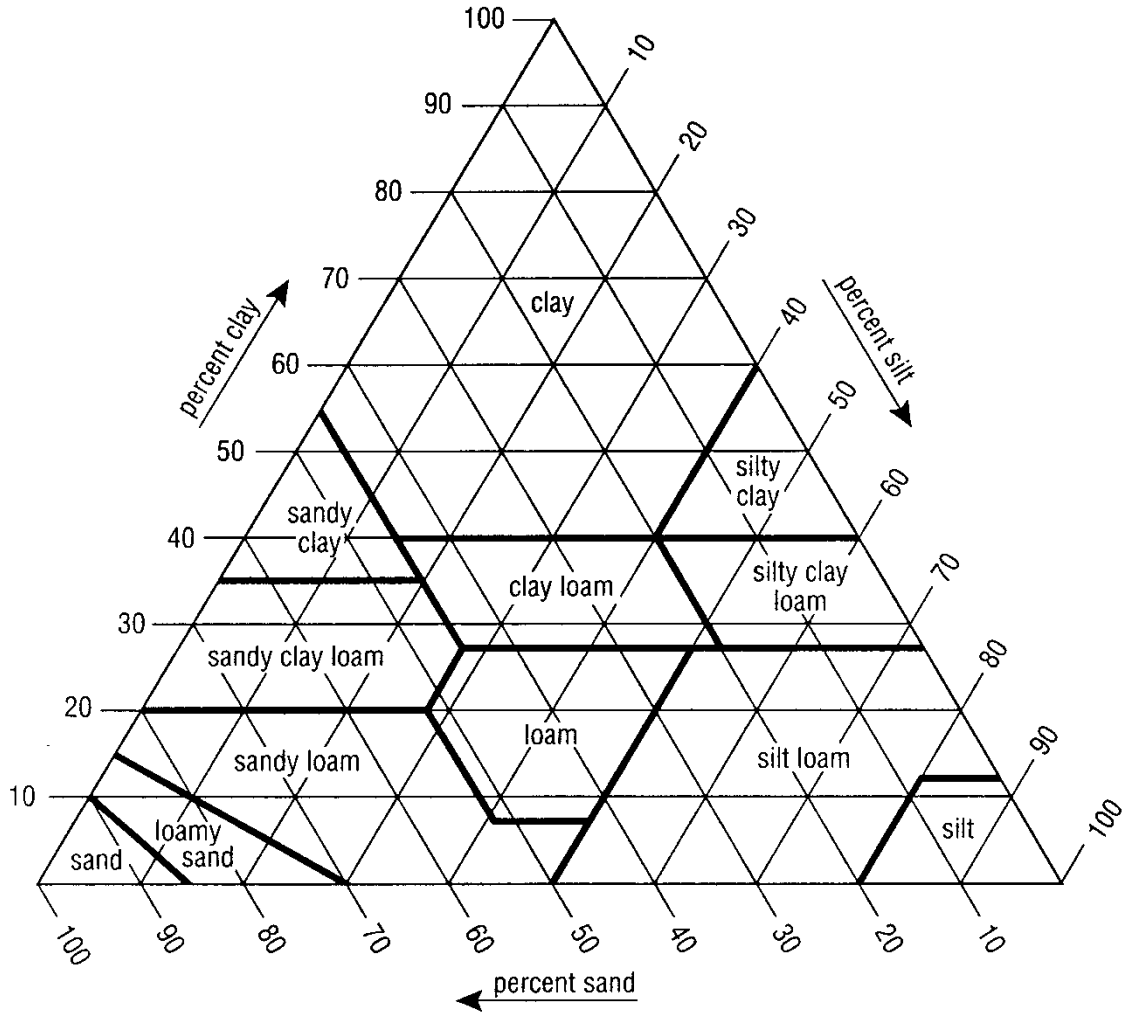
- USDA has 12 soil textural classes (see triangle

- Can be estimated by “feel”
- Can be measured by sedimentation



Soil Sedimentation Analysis

USDA Soil Textural Triangle



12 textural classes

sand
loamy sand

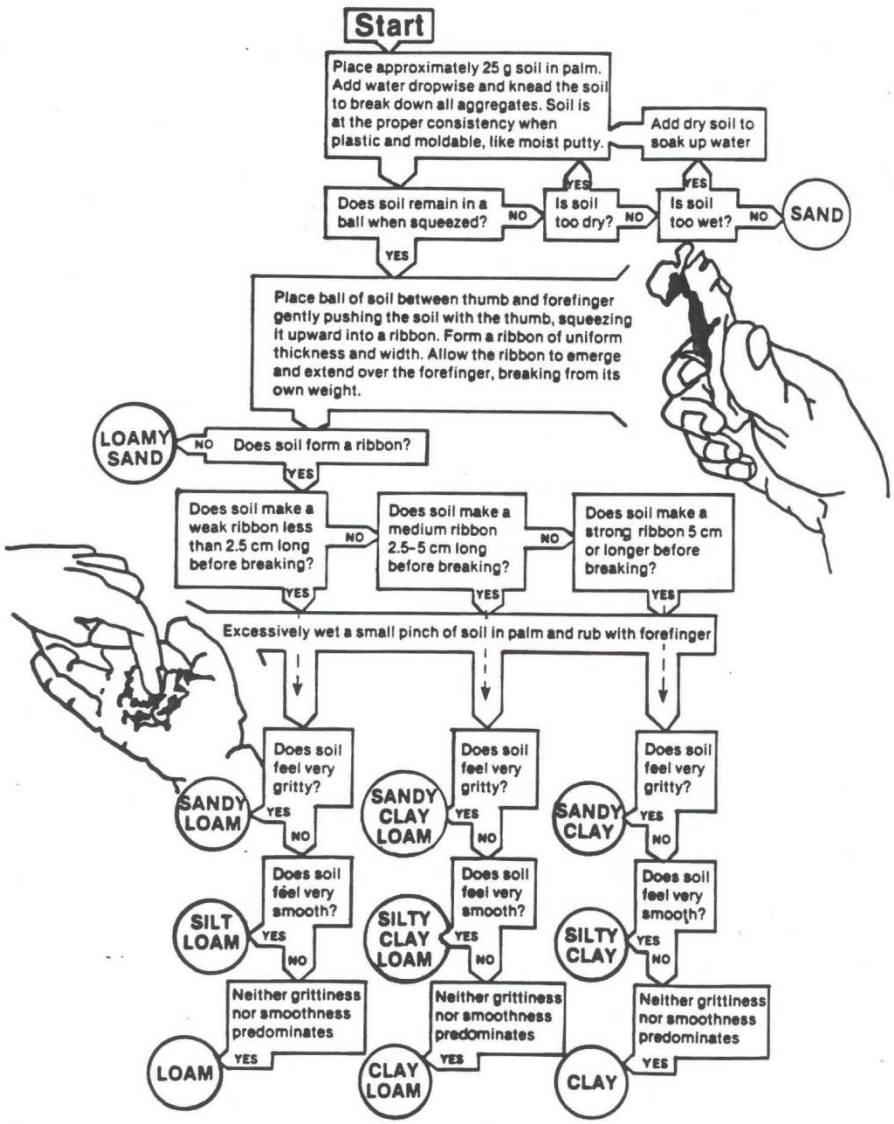
sandy loam
loam
silt loam
silt

sandy clay loam
clay loam
silty clay loam

sandy clay
silty clay
clay

Estimating Soil Texture

ACTIVITY 10 - Figure 5. Flow diagram for estimating soil texture by feel



Soil Properties
Texture Influences

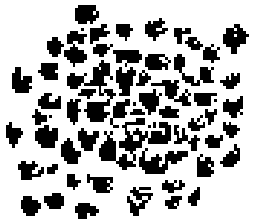
- Erodibility (silty high, sandy low)
- Strength (silty low, sandy high)
- Permeability (sandy high, clayey low)
- Bulk Density (sandy high, clayey low)
- Porosity (sandy low, clayey high)
- Available Water Capacity (sandy low, silty high)
- Infiltration (sandy high, clayey low)

Soil Structure

- Aggregation of particles into secondary units
- Influences porosity, erodibility
- Can be affected by use & management

  (can be an indicator of soil quality)

Types of Soil Structure



Granular - roughly spherical

A horizons (topsoil)

Platy - flat & horizontal

compacted soil

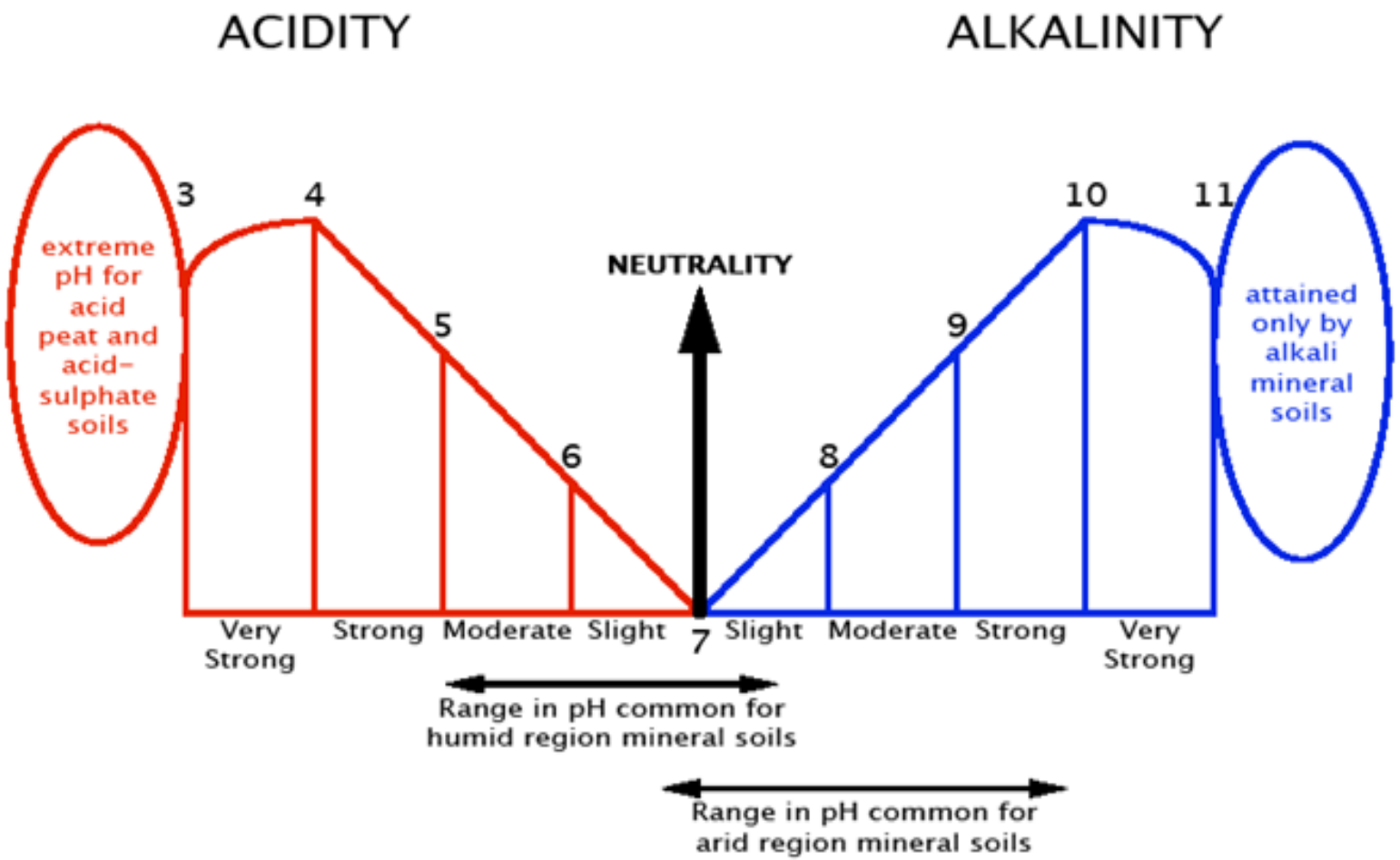
Blocky- subangular

B horizons (subsoil)

SOIL CHEMICAL PROPERTIES

- **SOIL pH - MEASUREMENT OF THE ACIDITY OR ALKALINITY OF THE SOIL**
- **CATION EXCHANGE CAPACITY - MEASUREMENT OF THE SOIL'S ABILITY TO RETAIN AND SUPPLY NUTRIENTS**

The pH Scale


ACIDITY
ALKALINITY
extreme pH for acid peat and acid-sulphate soils
3
4
5
6
NEUTRALITY
7
8
9
10
11
attained only by alkali mineral soils
Very Strong
Strong
Moderate
Slight
Slight
Moderate
Strong
Very Strong
Range in pH common for humid region mineral soils
Range in pH common for arid region mineral soils

5. Soil Surveys

- ✓ **Soil map**
- ✓ **Soil descriptions**
- ✓ **Soil ratings & interpretations**

- Many soil surveys are now available online at Web Soil Survey

USDA United States Department of Agriculture
Natural Resources Conservation Service

Web Soil Survey

Search
Enter Keywords Go
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Browse by Subject
- Soils Home
- National Cooperative Soil Survey (NCSS)
- Archived Soil Surveys
- Status Maps
- Official Soil Series Descriptions (OSD)
- Soil Series Extent Mapping Tool
- Soil Data Mart
- Geospatial Data Gateway
- eFOTG
- National Soil Characterization Data
- Soil Geochemistry Spatial Database
- Soil Quality
- Soil Geography
- Geospatial One Stop

The simple yet powerful way to access and use soil data.

START WSS

Welcome to Web Soil Survey (WSS)

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

Three Basic Steps

1 Define.

Mouseover to enlarge image.

Use the Area of Interest tab to define your area of interest.

2 View/Explore.

Click the Soil Map tab to view or print a soil map, or click the Soil Data Explorer tab

I Want To...
- Start Web Soil Survey (WSS)
- Know the requirements for running Web Soil Survey
- Know whether my web browser works with Web Soil Survey
- Know the Web Soil Survey hours of operation
- Find what areas of the U.S. have soil data

Announcements/Events
- Web Soil Survey 2.0 has been released! View description of new features.

I Want Help With...
- How to use Web Soil Survey
- Known problems and workarounds
- Frequently Asked Questions
- Citing Web Soil Survey as a source of soils data

Soil Map—Centre County, Pennsylvania
(Centre County)