2nd Stage of Horticulture Department

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TOPICS

- FACTORS THAT CONTROLLING SOIL FORMATION.
- SOIL FORMATION PROCESS.

When does soil form?

- **Soil parent material is** the material that has formed soil and may be rock that has weathered in place, or material that has been deposited by wind, water, or ice **such as Lava, volcanic ash, rock, dunes**

- Soil forms when weathered parent material interacts with *environment.*
- Soil *environment* includes:
  - Climate and weather
  - Animals
  - Microbes
  - Human use
  - Hazards (natural and unnatural)
  - Topographical relief

Soil formation is a slow and complex process

Weathering = Weathering is the breaking down or dissolving of rocks and minerals on the surface of earth. Processes that form the soil.

Physical (mechanical) = Wind and rain; no chemical changes in the parent material.

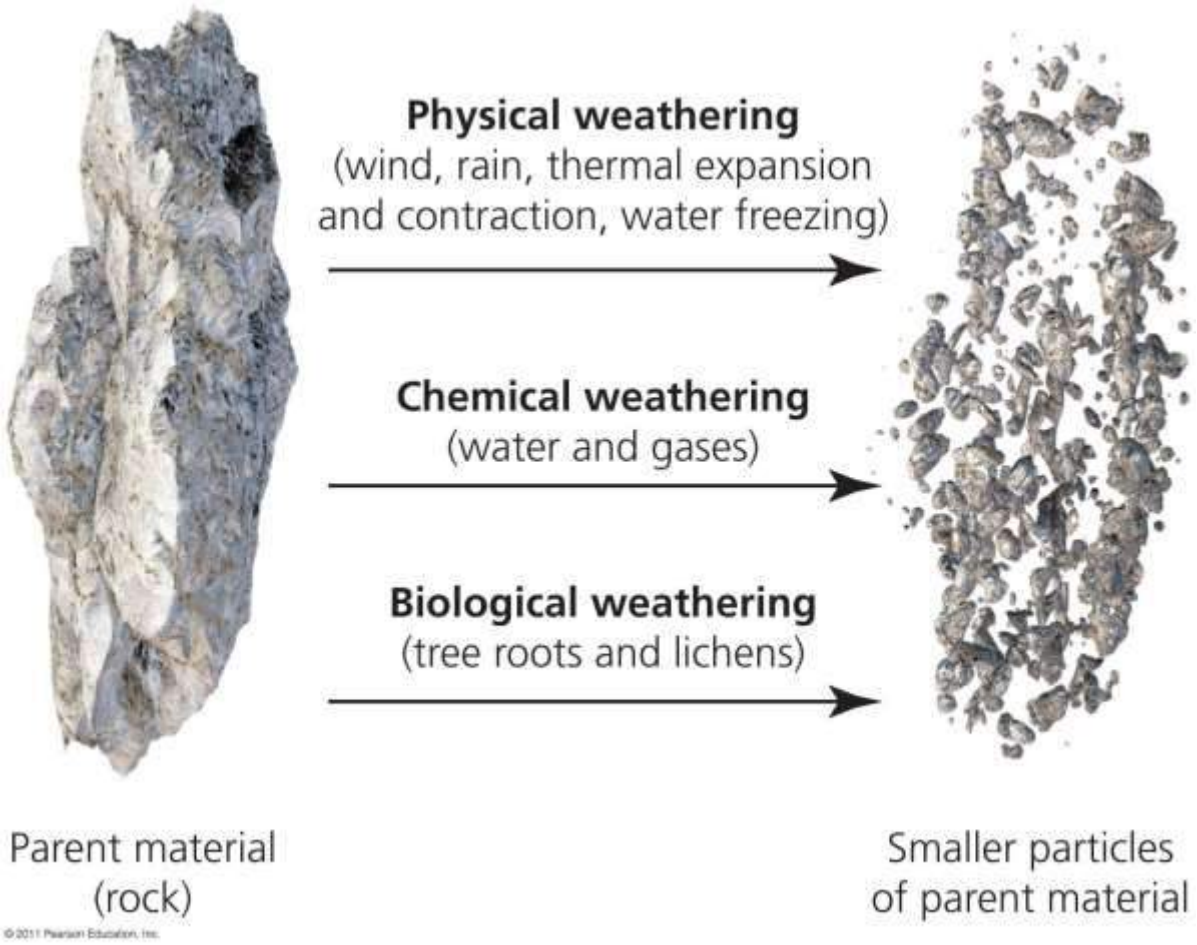
Chemical = Substances chemically interact with (PM) (chemically changed)

Biological = Organisms break down (PM) and produce soil through physical or chemical means.

Decomposition = the natural process of dead animal or plant tissue being rotted or broken down into simpler matter.(eg. Humus).

Humus = Spongy, fertile material formed by partial decomposition of organic matter

Weathering Turning Parent Material into Soil



Erosion vs Leaching

- **Erosion** is the process by which soil and rock are transported **(removed)** from the Earth's surface (exogenetic processes)
- by wind or water flow,
- and then deposited in other locations.

- **Leaching** is the removal of **soluble material** such as nutrients from soil or other material by percolating water

Factors That Controlling Soil Formation

The Jenny equation: Soil scientist, Hans Jenny has suggested that any type of soil found on any site is dependent upon the interaction of five factors:

1. Climate **(Cl)**
2. Biotic influences (plants, animals and micro-organisms) **(O)**
3. Topography (slope and aspect) **(R)**
4. Parent material **(P)**
5. Time. **(T)**

- ***S*** **=** ***F*** ***(*****Cl, O, R, P, T..*****)*** **Jenny equation**

1- Climate

- The term climate refers generally to **Effective precipitation (rainfall)** and **temperature** variables.

Climate largely determines

- ❑Speed and character of soil development.
- ❑Type and rate of weathering.
- ❑Living organisms and plants found in an area.

components of climate :

1. **Temperature**

   -for every 10°C , biochemical rxn rates 2X

2. ***Effective* precipitation**

   (water that moves through entire soil column, including regolith)

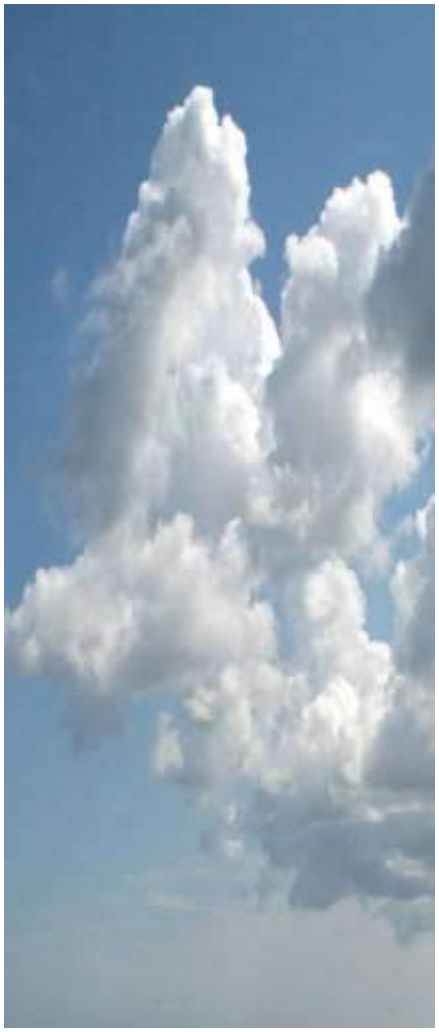
   -depth of water = depth of weathering

   -water moves soluble & suspended materials

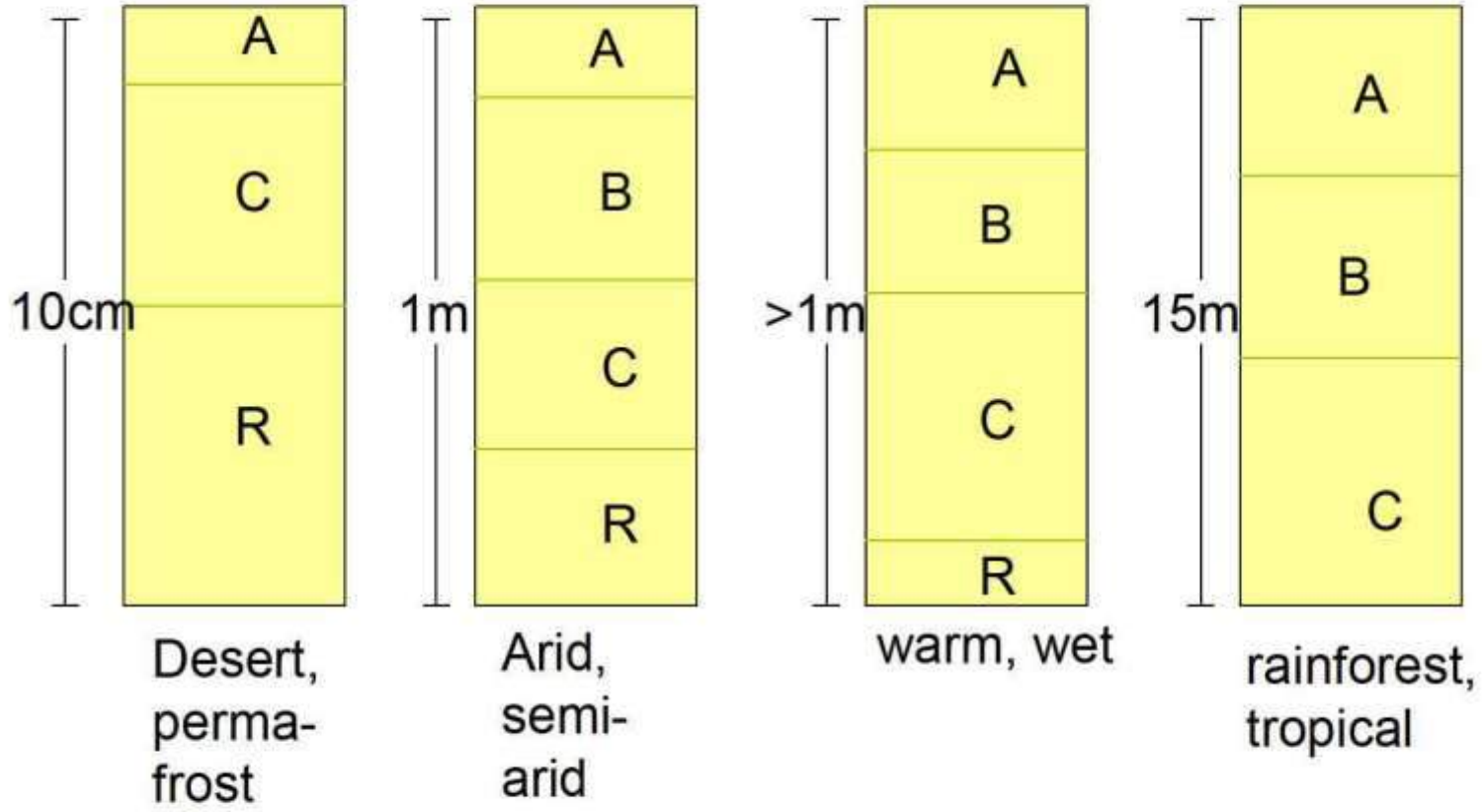
Climate

- ✓ **Climate** is the most important soil formation factor.
- ✓ Because, climate governs the **rate** and **type** of soil formation and its also the main determinant of **vegetation** distribution.

- ✓ Soils formed from the same parent material under different climates contrast.



Impact of climate to soil layering



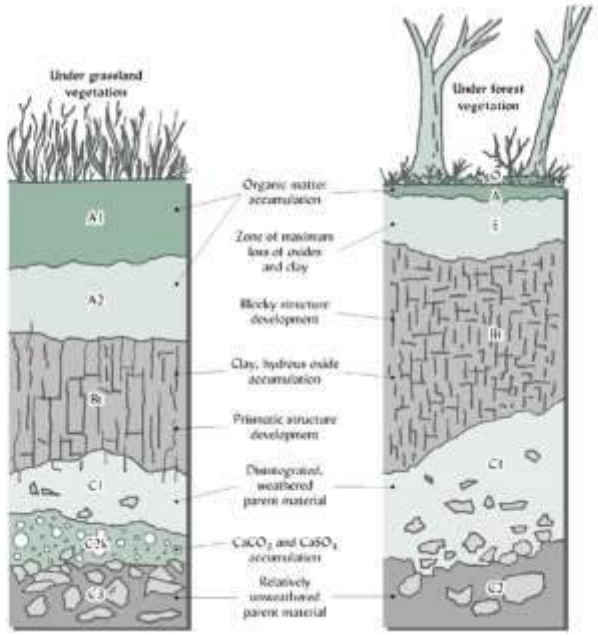
2- Organisms (plants and animals)

- **Plants and animals play important roles in soil formation.**

Plants

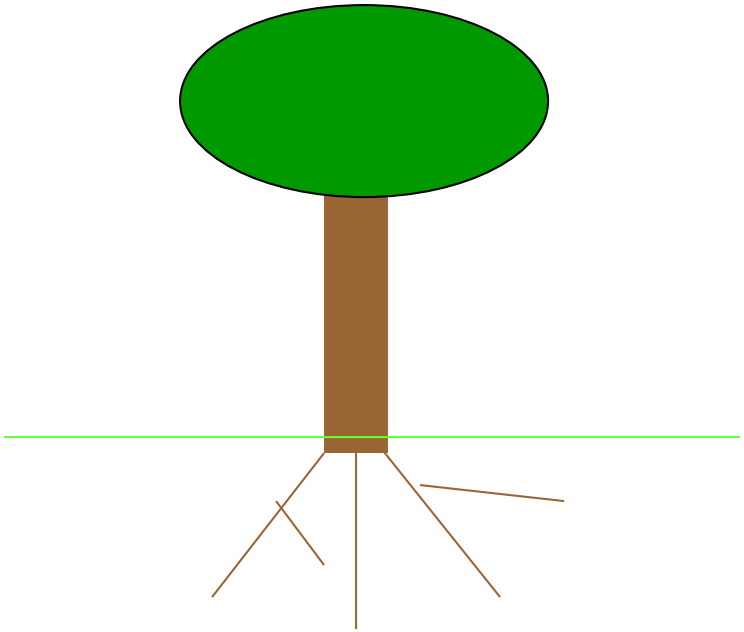
The types of plants can have an effect on the soil profile

- Soil type
- Base pumping
- Sources of organic matter
- Nutrient recycling
- Vegetation prevents erosion



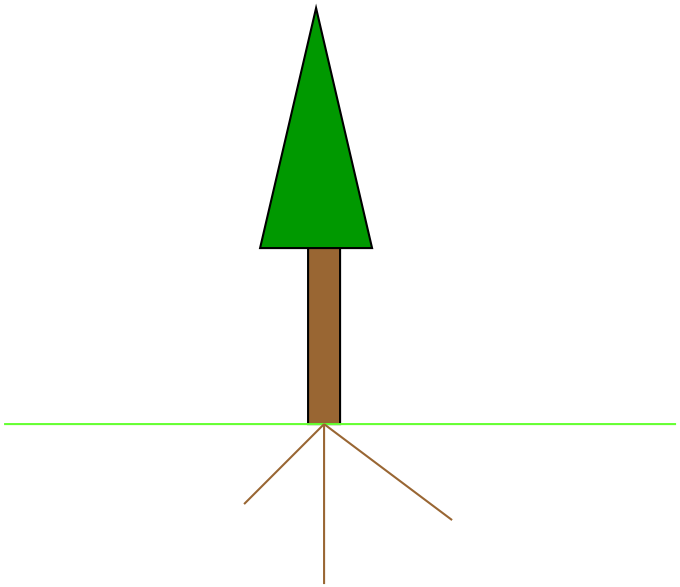
Base pumping

Deciduous trees are more effective base pumpers than conifers.



–deciduous litter is easy to break down

–cations (bases) are released so surface soils are not acidic



–needles are hard to break down

–basic cations leach away: soil is acidic

Animals

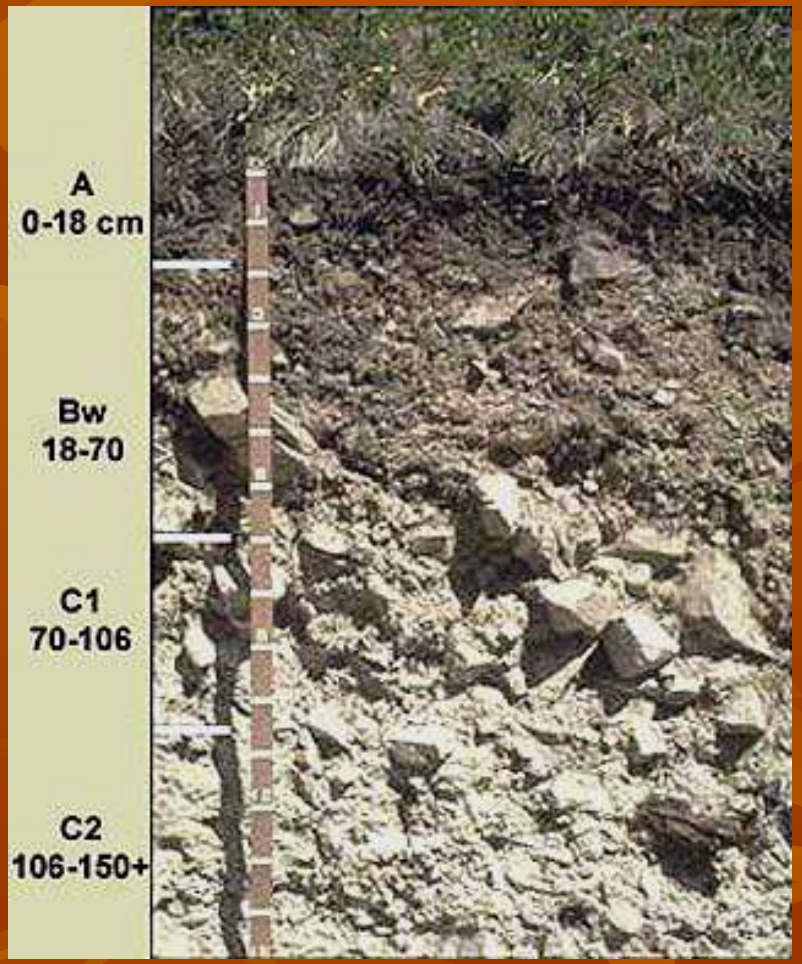
- Organisms helping soil development range from microscopic bacteria to large animals including human.
- Micro organisms such as bacteria and fungi assist in the decomposition of plant litters. This litter is mixed into the soil by macro organisms (soil animals) such as worms and beetles.
- Soil horizons are less distinct when there is much soil organism activity.

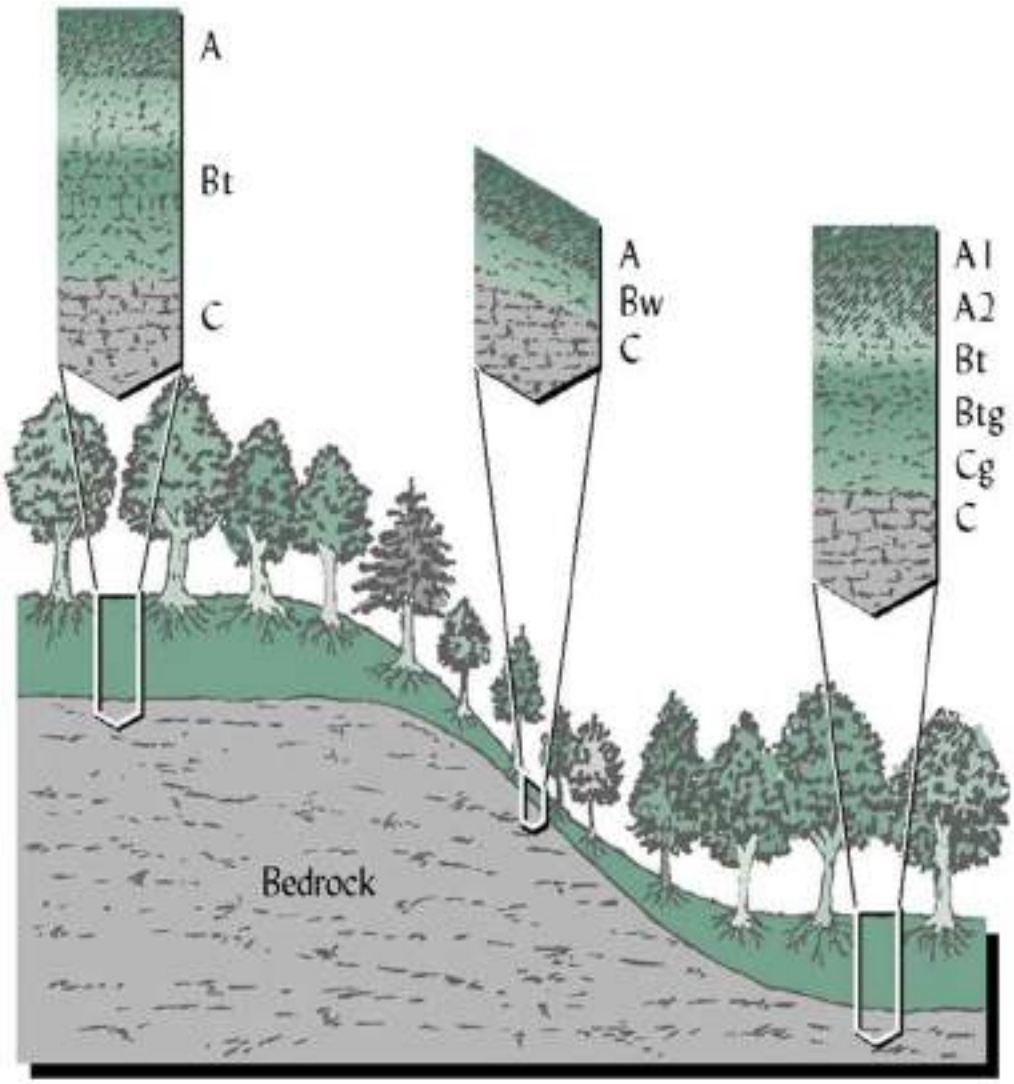
3-Topography/Relief

- Topography has an important effect in how soils form because it governs the movement of water.
- Topography consists of three parts: elevation, slope, and aspect.
- **Slope** is the tilt or inclination of the land.
- **Elevation** is the height above mean sea level.
- **Aspect** is the direction the slope is facing.

Soils on a Steep Slope

- As slopes increase, soils become shallower and have thinner and fewer horizons.
- This is because the steeper the slope the greater the runoff and the greater the erosion.




A
Bt
C
A
Bw
C
A1
A2
Bt
Btg
Cg
C
Bedrock

Topography Aspect

- Direction the slope faces - important when slope is > than 10 %.

- North Slope 1

  colder soils, less evaporation , less erosion ~ thus more soil development

- South Slope 2

  warmer soils, more evaporation, more erosion ~ thus less soil development.

4-Parent Material

Parent materials are the starting point for soil development, and their nature profoundly effect soil properties, especially in areas where chemical weathering has not destroyed or greatly modified the original minerals.

The parent material Determines soil

Color, texture, structure, mineral composition, permeability and drainage

Parent Material

Parent material (P): Parent material is the rock that soils are derived from. These include **igneous**, (both plutonic – granite and volcanic – basalt), **sedimentary** and **metamorphic** rocks.

The major primary minerals are:

- **Quartz (** SiO_4)
- **Feldspars (**AT_4O_8**),** A = potassium, sodium, or calcium (Ca); and T = silicon (Si) and aluminum (Al)
- **Mica (**$KAl_3Si_3O_{10}(OH)_2$**)**

Elements → Minerals → Rocks

Parent materials

- Weathering
- Soil Forming Process

Soil

5- Time as a Soil Forming Factor

- The amount of time that parent materials have been subject to weathering and soil forming processes effects soil properties or **Duration of exposure parent material to weathering.**

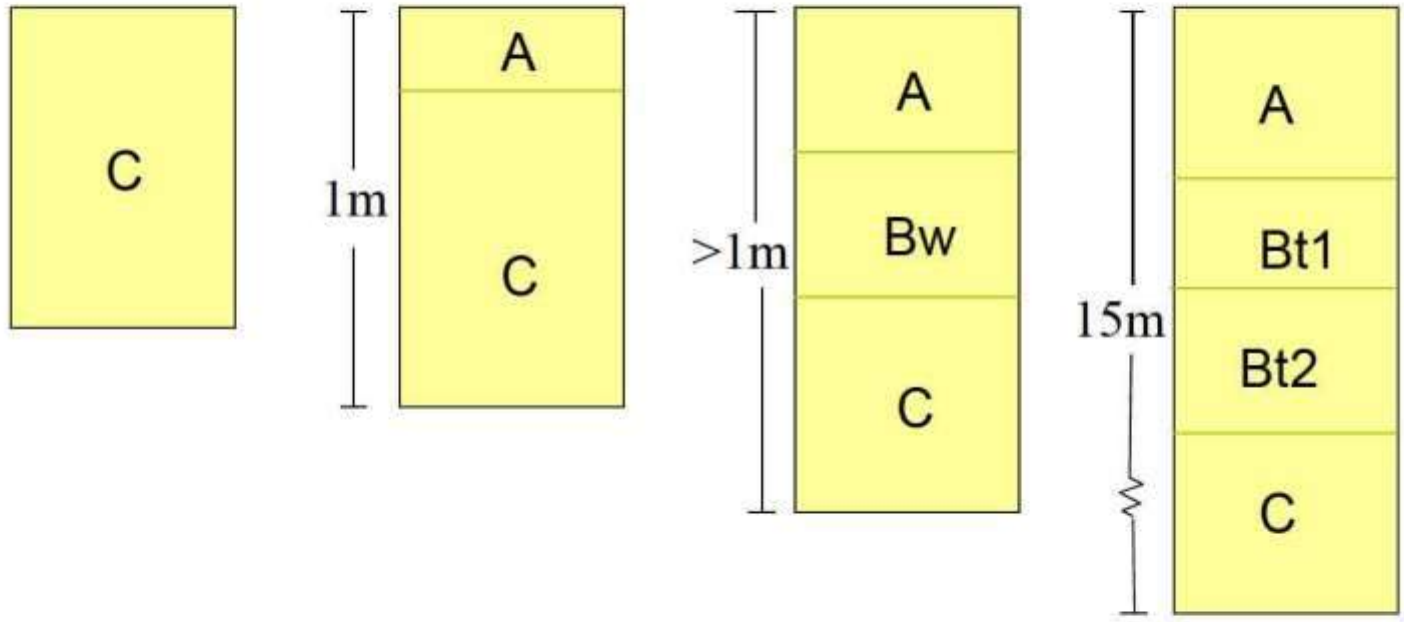
- Residual parent materials have generally been subjected to soil forming processes longer than transported parent materials.

- Time is important in soil formation because it determines the degree of other soil forming factors express themselves.

- In wet tropical areas soil formation is faster, as it takes 200 years.

- In order to accumulate enough substances to make a soil fertile it takes 3000 years. For these reasons the soil is considered as a non-renewable resource!

Time development of the soil profile



maternal bedrock

"young profile"

"mature profile"

"highly mature profile"

Young soil

Matured soils

Old soils

Why does Soil varies from place to place?

Because the intensity of factors varies from location to location.

A

B

C

D

Processes of Soil Development

4 basic processes in the soil

ADDITIONS

LOSSES

TRANSLOCATIONS

(MOVEMENT WITHIN THE SOIL)

TRANSFORMATIONS

(ONE COMPONENT CHANGES TO ANOTHER)

ADDITIONS

Materials can be added to the soil in many ways.

- **Rain adds water.**
- **Dust adds minerals.**
- **Animal wastes add organic matter and nutrients.**
- **Humans add fertilizer.**

LOSSES

Losses are removal of components from the soil profile

- **Water evaporates into the air.**
- **Soil particles wash away in storms.**
- **Organic matter may decompose into *carbon dioxide.***
- **Nutrients and minerals leach into groundwater or are taken up by plants.**

TRANSLOCATIONS

MOVEMENT WITHIN THE SOIL

- **Gravity pull water down from top to bottom.**
- **Evaporating water draws minerals up from bottom to top**
- **Organisms carry materials every direction.**

TRANSFORMATIONS

(ONE COMPONENT CHANGES TO ANOTHER)

- **Dead leaves decompose into humus.**
- **Hard rock weathers into soft clay**
- **Oxygen reacts with iron (ferric oxides), “rusting” the soil into a reddish color.**


THE END
THANK YOU