

Today

- Models of soil formation
- Soil taxonomy
 - Horizon descriptions

(1) Parent materials + 4 other factors of soil formation

- Climate
- Topography
- Time
- Biota

Can be interrelated and interact

Climate

- Moisture
 - Quantity
 - Intensity
 - distribution
- Temperature

Role of water

- Essential for chemical weathering
- Transport materials through horizons
- Determine type of plant cover

Rainfall: Intensity and duration



Effective precipitation

- Water has to go into the soil
 - Infiltration - not overland flow
 - Rainfall exceeds evaporation

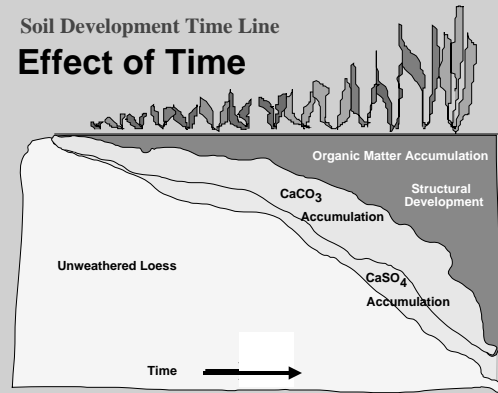


Temperature

- Rate of biological activity
- Rate of chemical reactions

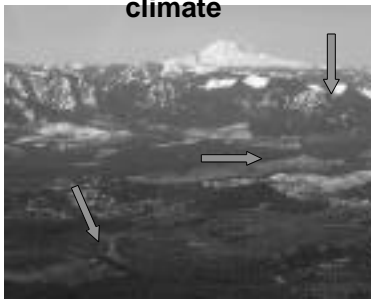


Soil Development Time Line Effect of Time



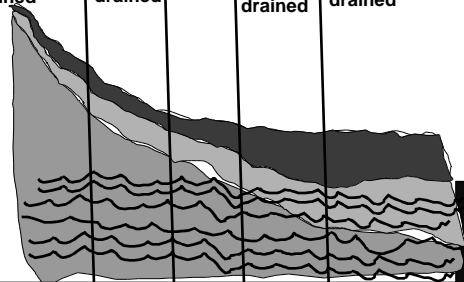
Topography

Same parent material, same climate



Toposequence

Excessively drained | Well drained | Poorly drained | Very poorly drained



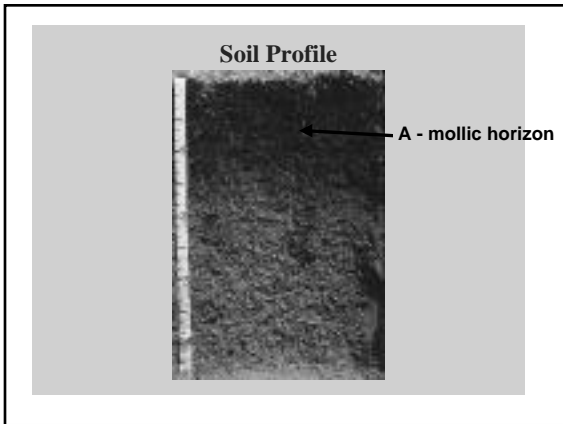
Biota - plants



Type of plant : Grass

- Dense root system
- Above ground foliage will die annually
- Grows where moisture < trees
- Thick A horizon





Tree - deciduous

- Leaves high in cations (Ca, Mg, Fe..)
- Annual leaf fall
- Well developed A horizon
 - Decomposed OM
 - High nutrients

Deciduous -

- Larger A horizon
- More cations
- Less acidic
- More clay translocation

Tree - coniferous

- Leaves low in cations
 - Acidic
- Little leaf fall
- Thin A horizon
 - Oi - slightly decomposed
- E horizon
 - eluviation

Coniferous - Acidic

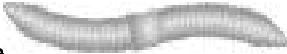
- Thin A
- E - eluviation washing out
- B - illuviation Washing in

Animals

- Pedoturbation
 - Animal burrows effectively mix soil from different horizons

Animals

- Earthworms
 - Soil mixing
 - Soil structure
 - Soil aeration



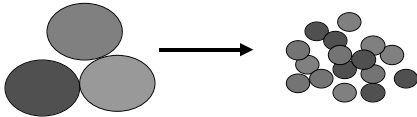
Animals

- Humans
 - Agricultural practices
 - Accelerate soil loss
 - Accelerate soil formation



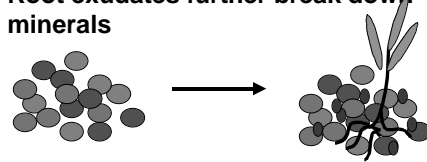
Start with a pile of rocks

- Physical and chemical weathering
 - Breakdown particles
 - Change mineral structure



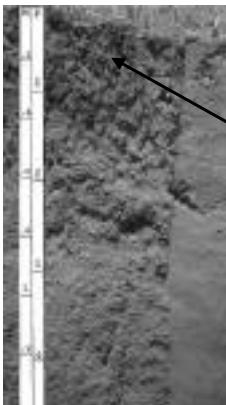
Plant starts growing

- Organic matter is added to soil surface
- Root exudates further break down minerals



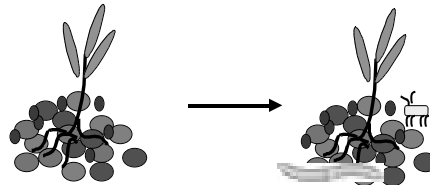
First stage of soil formation

- Increased organic matter in A horizon



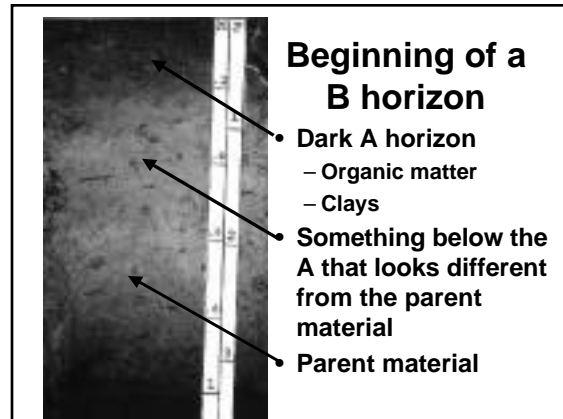
When a plant starts growing

- Organic matter from plants is a nutrient source for other organisms



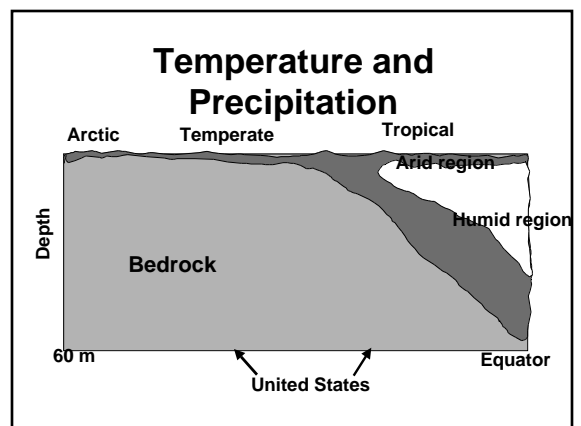
Next stage will involve development of a B horizon

- Cations that have been solubilized by plant exudates, microbial activity, and acidification will start moving lower into the soil
- Secondary clays have been formed in A and are also moving down the profile



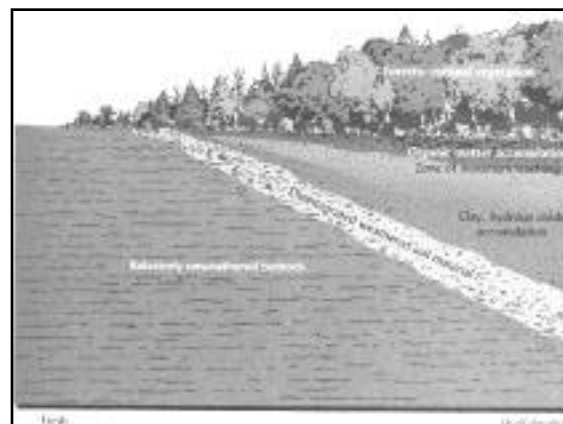
Next stage will depend on climate and parent materials

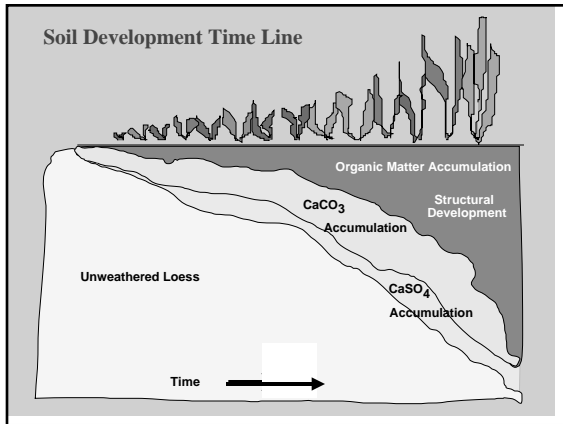
- Rainfall and temperature will determine nature of vegetation
- Resistance of parent material to weathering will determine rate and type of clay formation, acidity
- Rainfall (effective precipitation) will determine extent of translocation



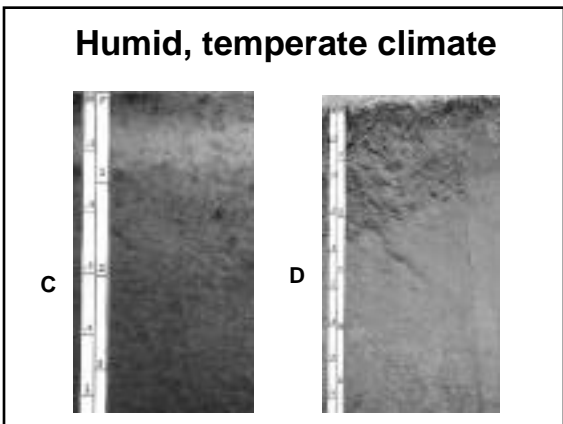
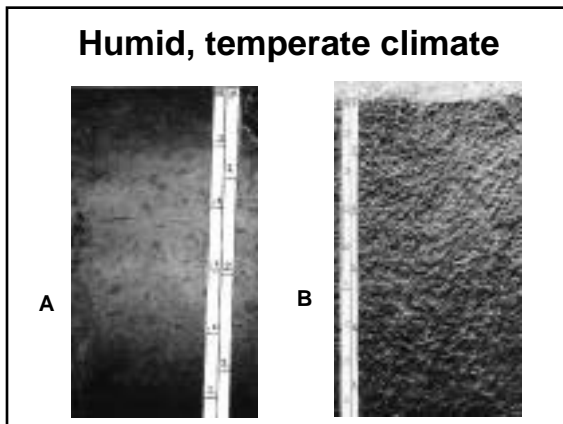
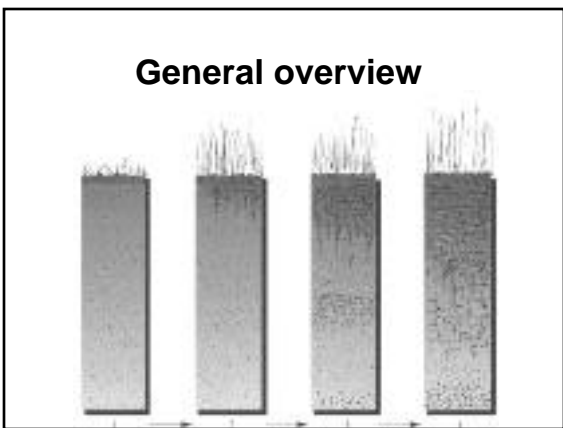
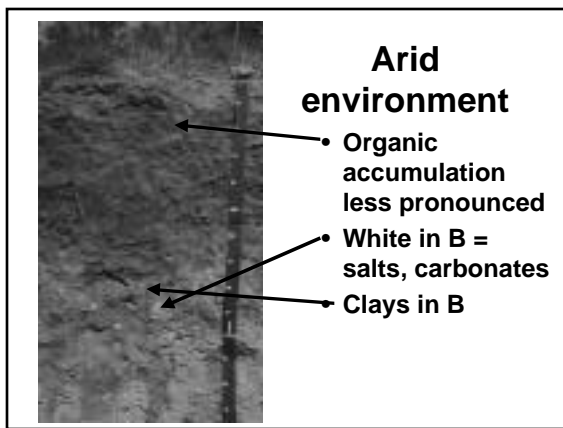
Progression in soil development

- High rainfall
- Moderate rainfall
- Low rainfall





- Arid environment**
- Less organic matter accumulation in surface
 - Less translocation of clays, cations
 - Cations never leave the profile
 - Accumulation of salts (cations)



Soil Taxonomy

- Language and terminology used to identify, characterize, and classify different types of soils
- Using this, you can understand origins of soil as well as productivity of soils

Description of an individual soil:

- Pedon - smallest 3D unit that displays characteristic of an individual soil



Tools to study soil development

- Horizons
 - O- organic horizon, consists of OM in various stages of decomposition
 - Occurs in forests

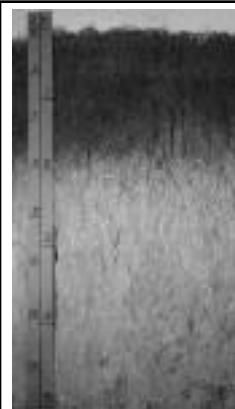


O Horizon

- Oi - slightly decomposed
 - Source of material easily recognized
- Oe - moderately decomposed
 - some recognizable components
- Oa - highly decomposed
 - primarily organic, not recognizable

Horizons

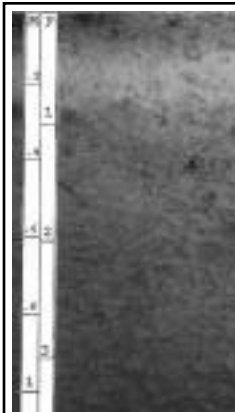
- A- surface horizon, dark in color due to OM accumulation, coarser in texture due to translocation of finer clays



Horizons

- E- forms below O,A horizons
 - horizon of loss (clays and cations) from eluviation
 - Generally lighter in color than A or B horizon
 - Acidic parent material





- **B-** forms below O,A,E horizons
 - horizon of accumulation (clays and cations) from illuviation
 - sufficiently altered so it is no longer recognizable as parent material

Horizons

- **C-** At the bottom
 - insufficiently changed from parent material to qualify as part of the solum



Words to further describe each horizon

- These descriptives are used to classify a soil
- Different tools to delve into particular characteristics of the pedon under investigation

Epipedon - to characterize A horizon

- **Mollic** - >25 cm thick, >0.6% C, soft when dry, high cation
- **Umbric** - same as above, but cations (%base saturation) lower
- **Melanic** - high OM, fluffy, on volcanic soils

Epipedon - to characterize A horizon

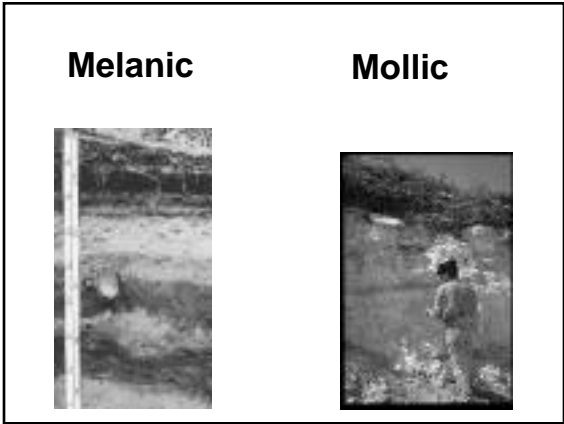
- **Histic** - accumulation of OM overlaying a mineral soil, wet
- **Ochric** - OM but not enough to qualify for other designations



Ochric



Histic



Salic

- Surface accumulation of soluble salts, usually occurs in dry climates where moisture in subsoil is wicked to the surface

Beginnings of a B horizon

- Cambic - some indications of change, usually a color difference

Cambic →

- Albic - more pronounced, light color with clay, Fe and Al removed

Subsurface Horizons

- Argillic (Bt)
 - High accumulation of clays in the B horizon
 - See them as coatings or skins

Clay skins

- Argillia (clay) - skins on the surface of particles in the B horizon

Natric (Btn)

- Clay skins with exchangeable Na > 15%, columnar or prismatic soil structure

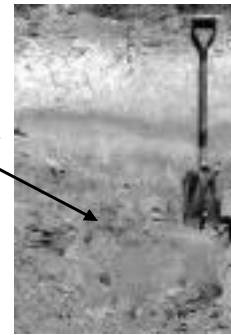
Prismatic

- Common in B horizons in arid areas (where you will have high salt accumulation)



Subsurface Horizons

- Kandic accumulation of Fe and Al oxide clays in the B horizon



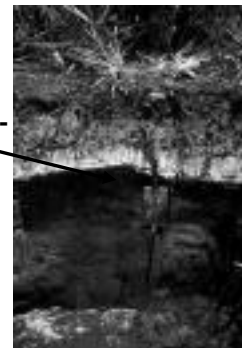
Subsurface Horizons

- Oxic (Bo)- very high Fe and Al, few weatherable minerals, > 30 cm deep



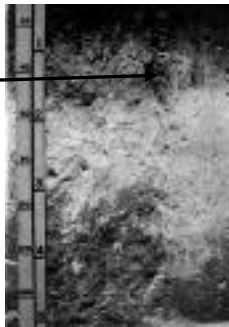
Subsurface Horizons

- Spodic (Bh, Bs)- illuvial horizon, below E, high in OM, Al and Fe oxides
- Found in primarily in acidic soils



Subsurface Horizons

- Calcic (k)- accumulation of carbonates, can appear as white nodules



Cemented horizons

- Duripan (qm) - Hardpan, strongly cemented by silica
- Fragipan (x) - Brittle pan, dense
- Petrocalcic (km) Cemented calcic horizon
- Petrogypsic (ym) Cemented gypsic horizon
- Placic (sm) Cemented with Fe, Mn, OM

Petra - rock in greek

Petrogypsic (ym)
Cemented gypsic
horizon



Petrocalcic (km)
Cemented calcic
horizon



Cemented horizons:

- Impermeable or slowly permeable by water
- Barrier to root growth



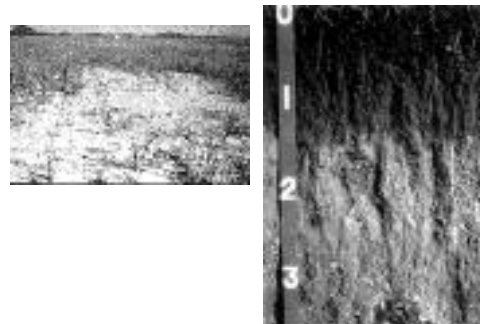
You are in a forest

- There are pine trees all around
- It's raining
- The ground is level
- The surface soil has a lot of leaf litter and feels sandy
- What would you expect the soil to look like?



You are on the prairie

- The areas all around you are covered with grass
- It's sunny and dry
- The soil where you are standing has much less grass and a white crust on the surface
- What would you expect the soil to look like?



Moisture regimes

- Aquic
- Udic
- Ustic
- Aridic
- Xeric



Temperature

- Classifications based on soil T at 50 cm depth
- Consideration differences between summer and winter averaged

Temperature

- Include terms like:
Frigid, Mesic, Hyperthermic
Cold Moderate Hot
ISO (greek meaning same)
Isofrigid, Isomesic, Isothermic