

Soil: Foundation of Forest Ecosystems

- Objectives
 - Overview of soils as the foundation for forest ecosystems and their management
 - Soil development and formation
 - Physical properties of soils
 - Chemical properties of soils
 - Biological properties of soils

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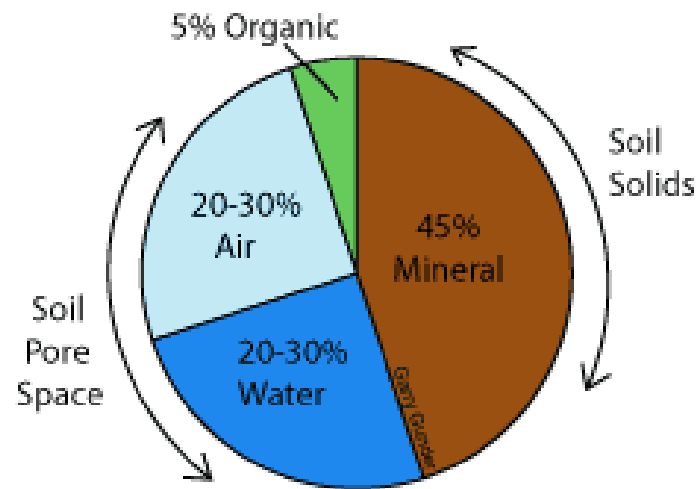
- Soil & Forest Management
 - Soils are a major determinant of site productivity
 - Soils largely determine forest growth & management activities
 - Forest management often occurs on ↓ fertility sites
 - Adverse vs. beneficial activities of forest management
 - Soil stability, compaction, roads, etc.
 - SOM, nutrients, and soil chemistry
 - Soil temperature

One of the essential education requirements for foresters... must surely be a sound working knowledge of soils (Kimmins 2004).

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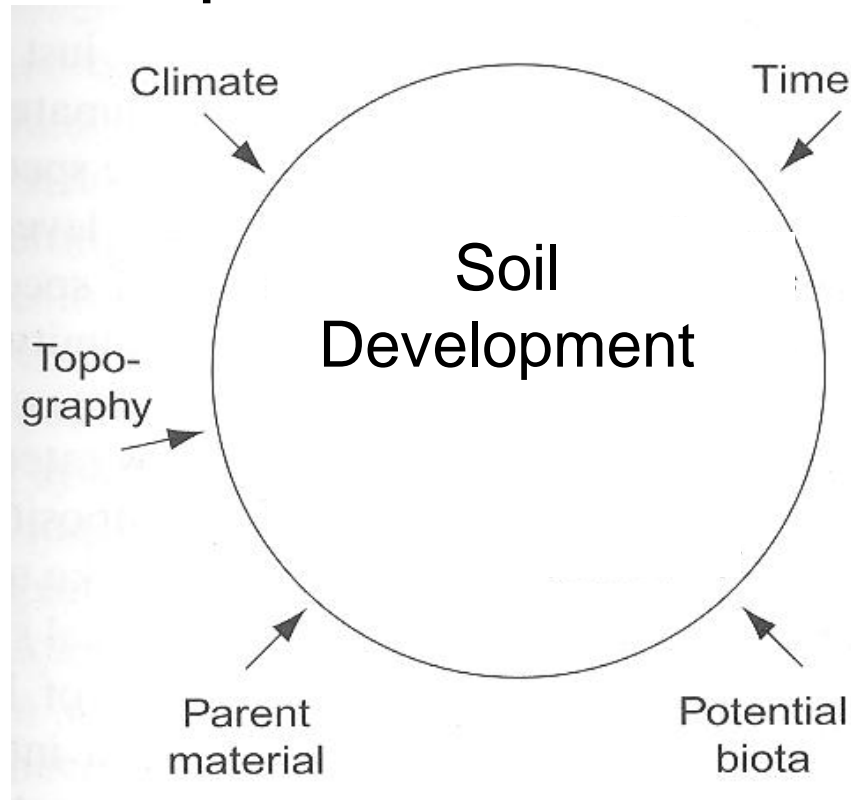
- Soil Composition

Soil Composition by Volume



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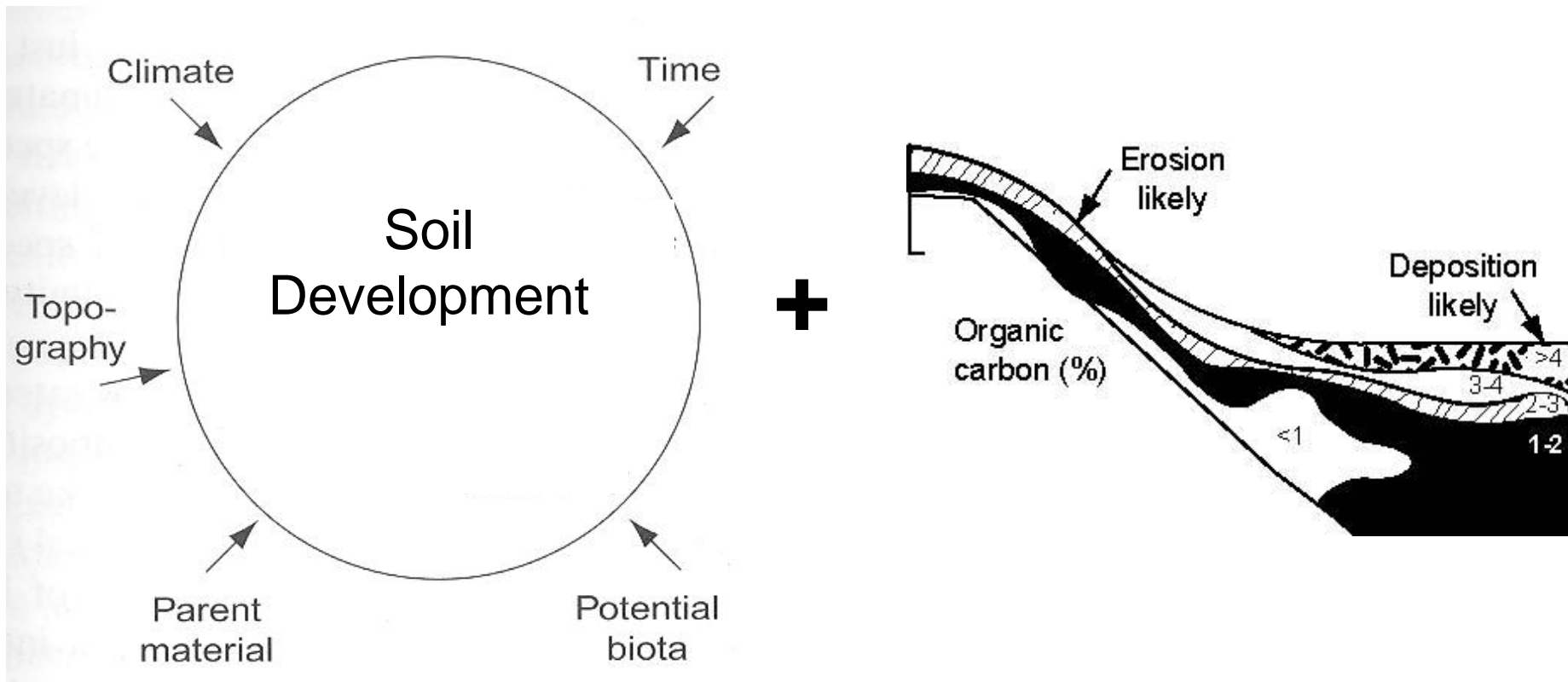
- Soil Development



$$\text{Soil development} = f(\text{climate, parent material, topography, biota, time})$$

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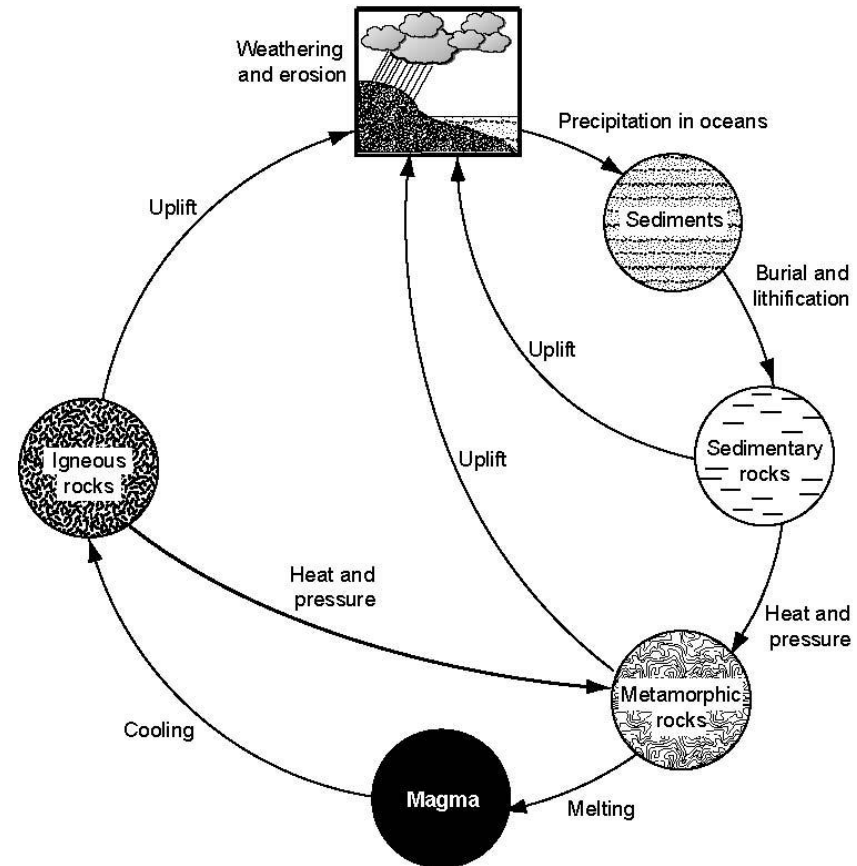
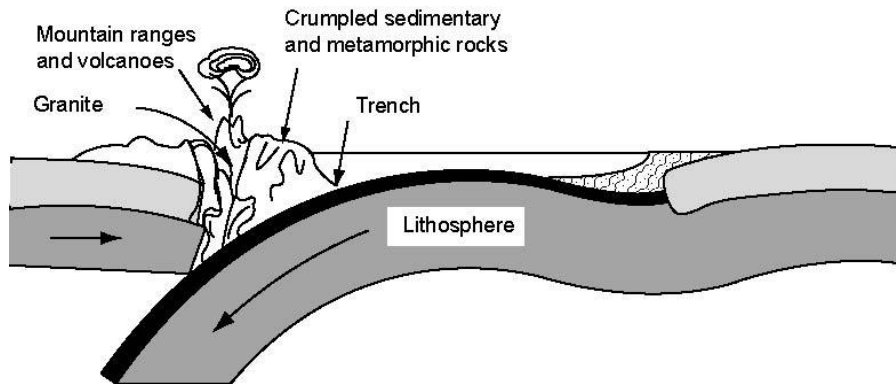
- Soil Formation



$$\text{Soil formation} = f(\text{development, erosion, deposition})$$

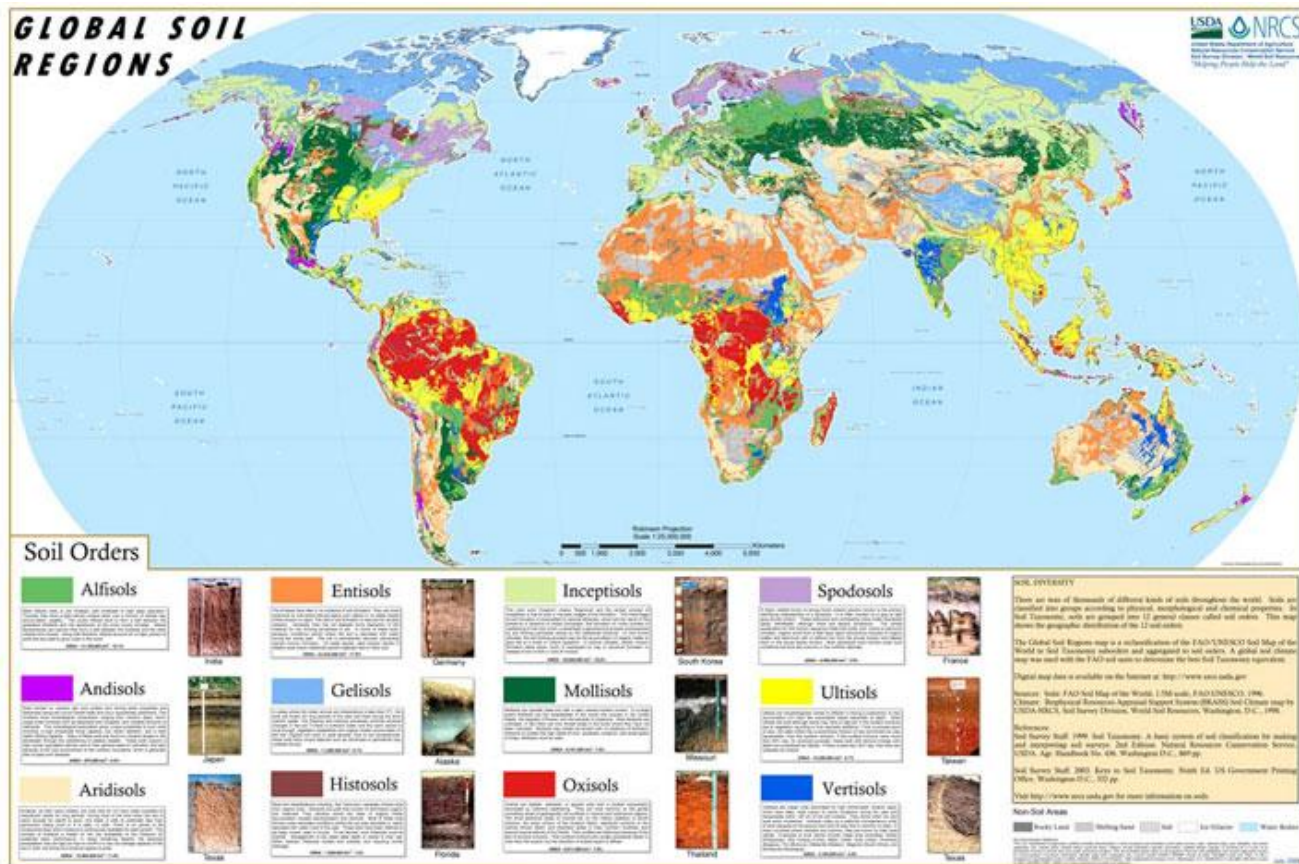
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- Parent material



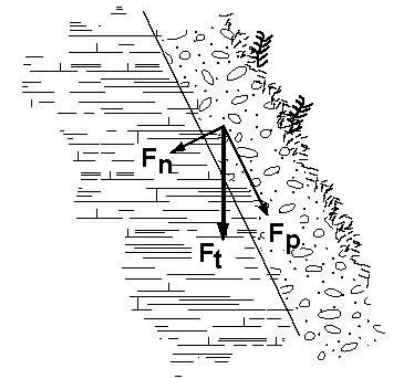
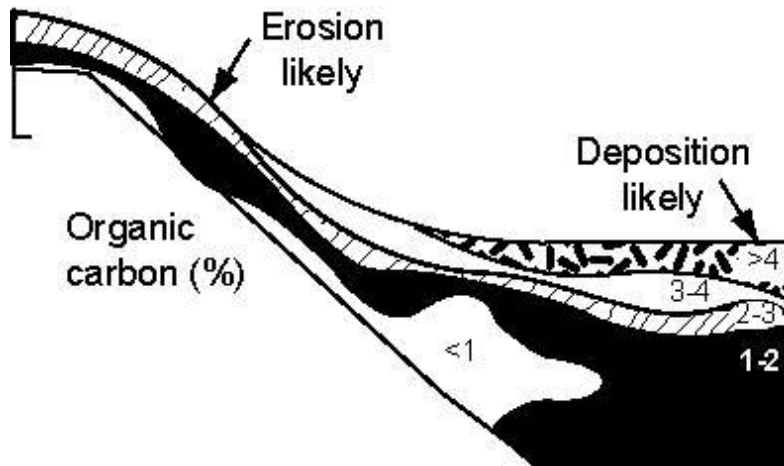
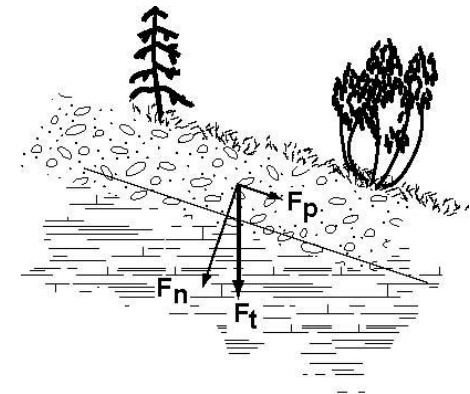
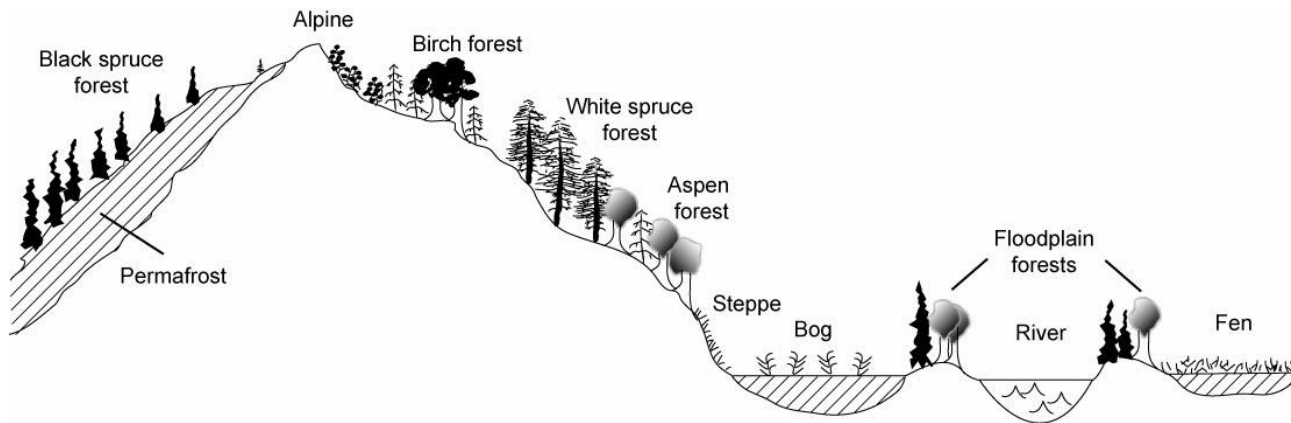
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- Climate



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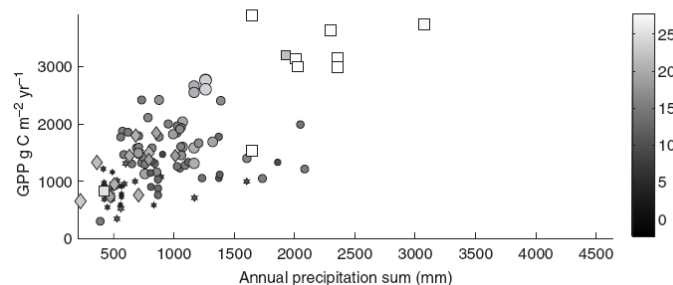
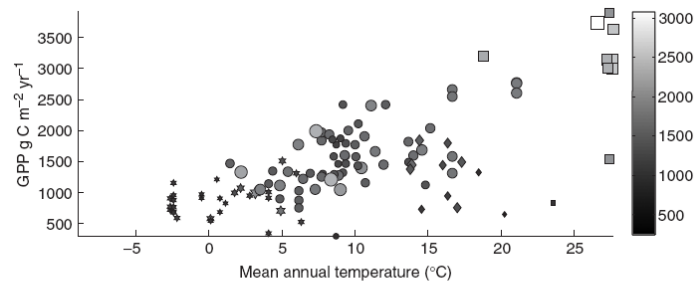
- Topography



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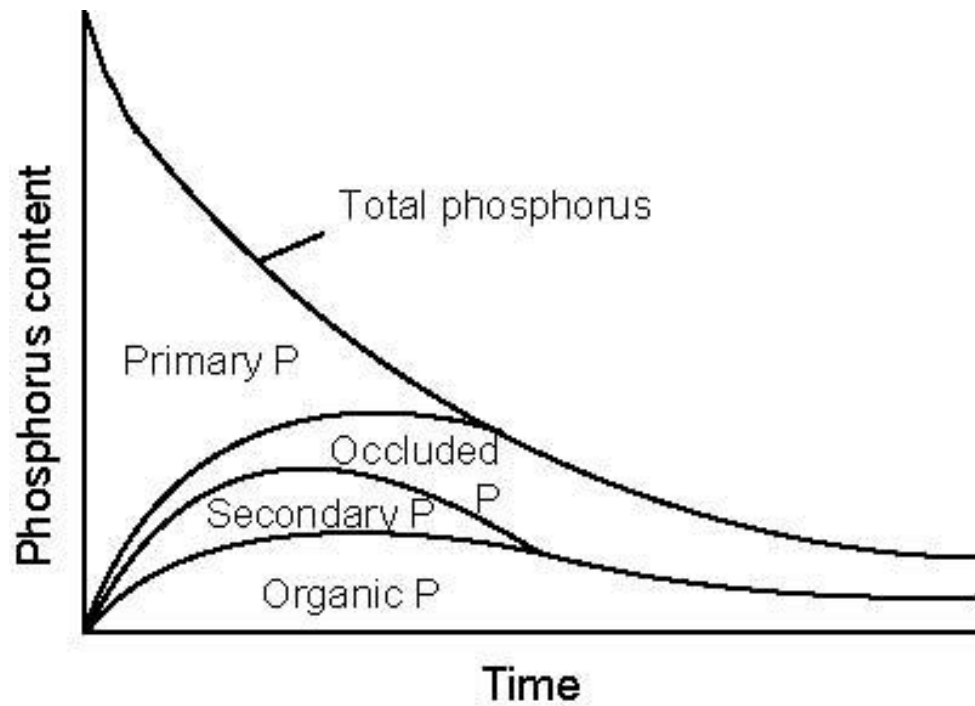
- Biota

- Physical weathering (plant roots)
- Chemical weathering (carbonic acid)
 - $\text{H}_2\text{O} + \text{CO}_2 \leftrightarrow \text{H}^+ + \text{HCO}_3^- \leftrightarrow \text{H}_2\text{CO}_3$
- Productivity \rightarrow organic matter quantity and quality



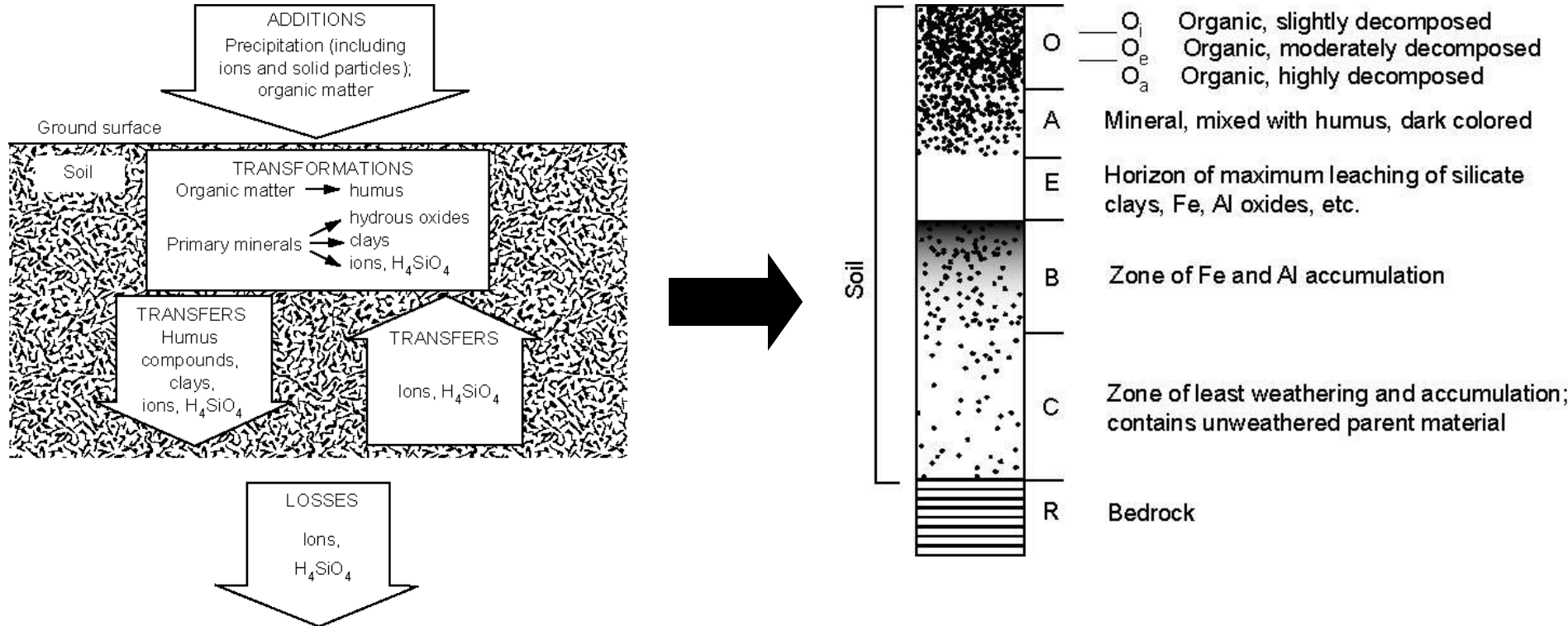
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- Time



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- Soil Profile Development

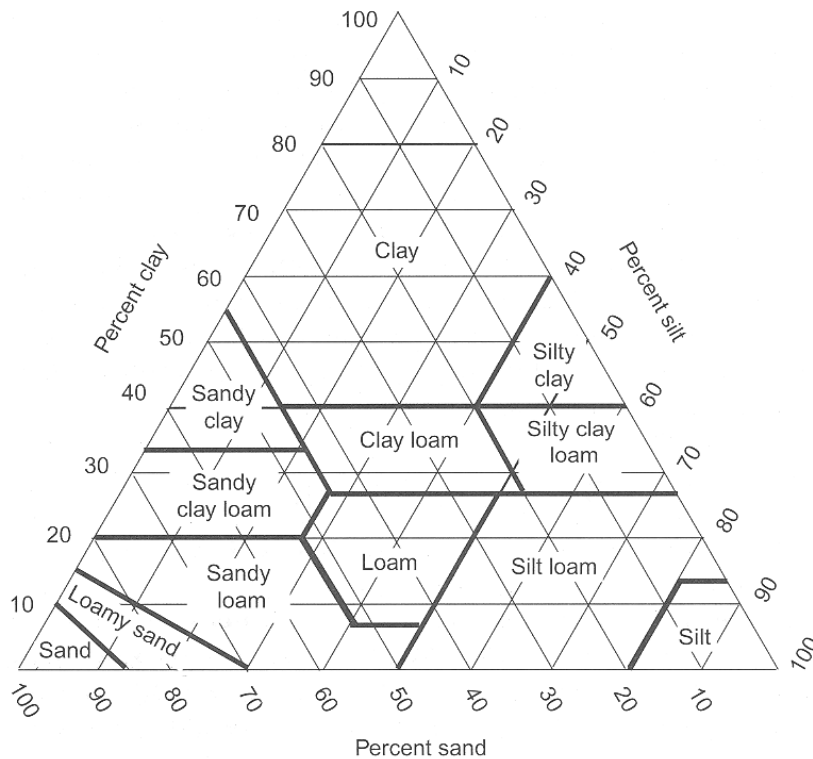


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- Soil Physical Properties
 - Texture
 - Structure
 - Bulk density
 - Water-holding capacity

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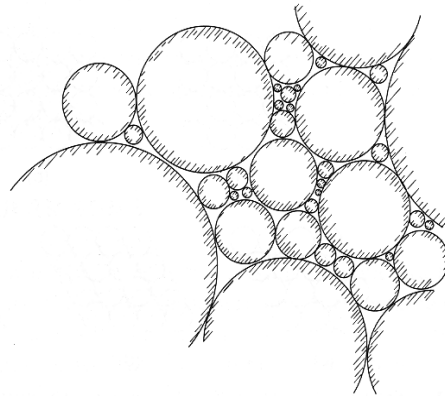
- Soil Physical Properties - Texture



Clay: <0.002mm
Silt : 0.002 – 0.02mm
Sand: 0.02 – 2.0mm

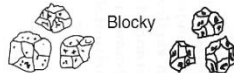
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- Soil Physical Properties - Structure



Granular

Platy



subangular

Blocky

angular



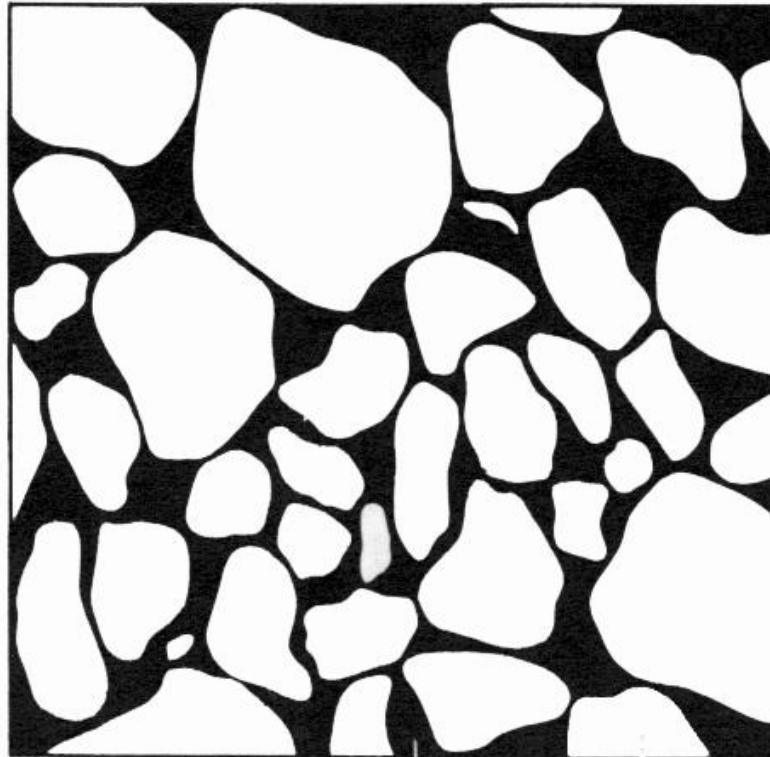
Columnar



Prismatic

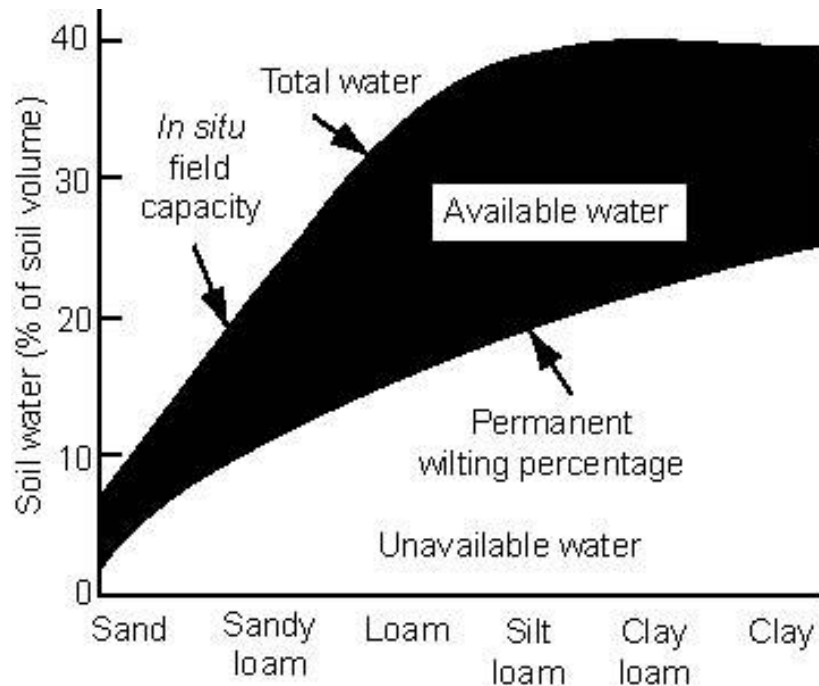
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- Soil Physical Properties – Bulk Density



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- Soil Physical Properties – Water Holding Capacity (WHC)

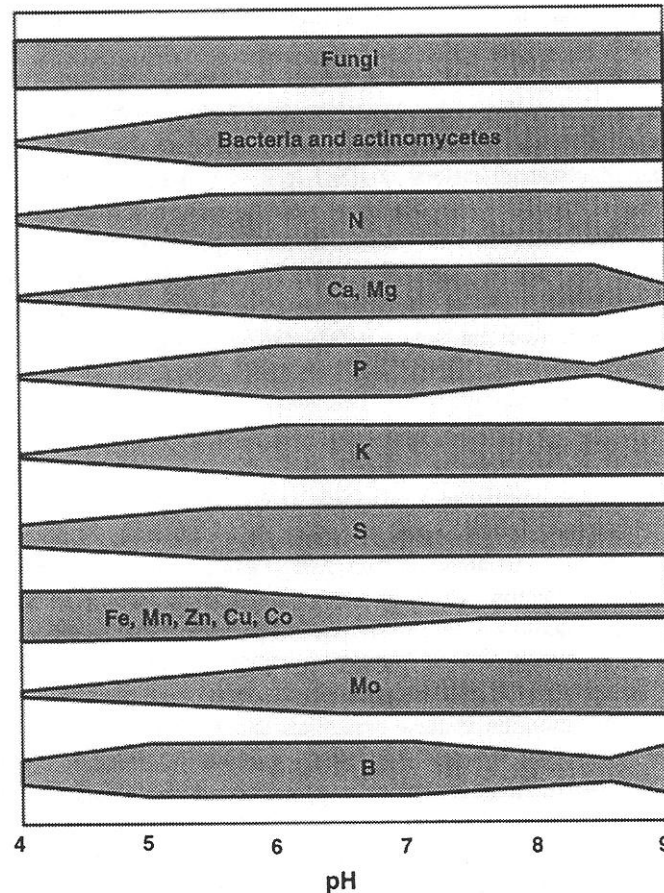


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- Soil Chemical Properties
 - Redox potential
 - pH
 - organic matter content
 - Ion exchange capacity (CEC and AEC)

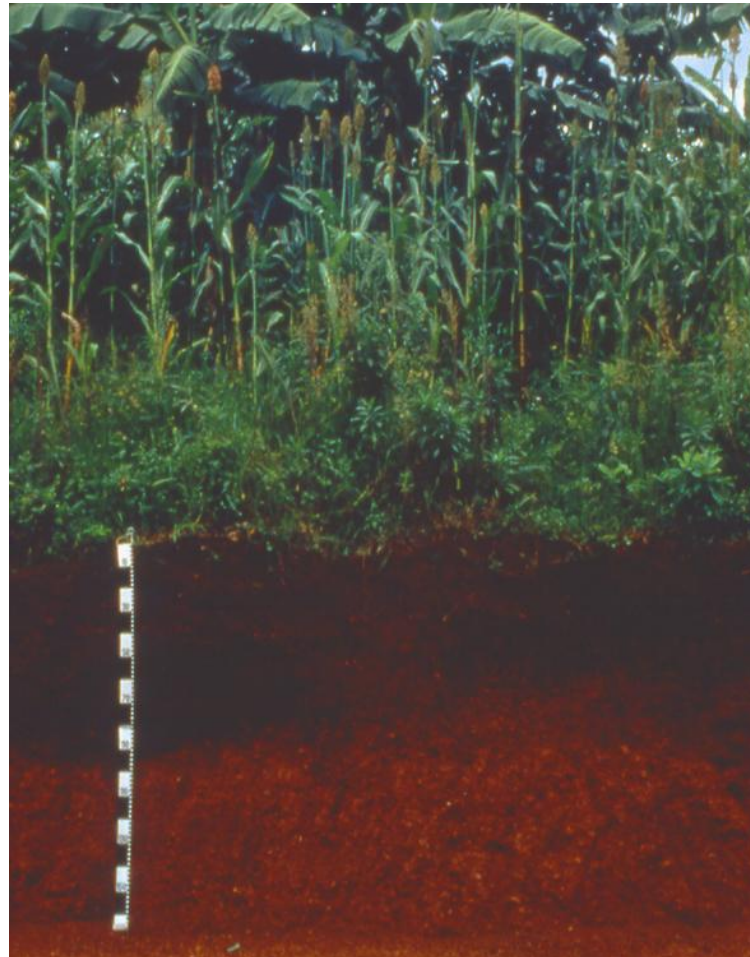
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- Soil Chemical Properties - pH



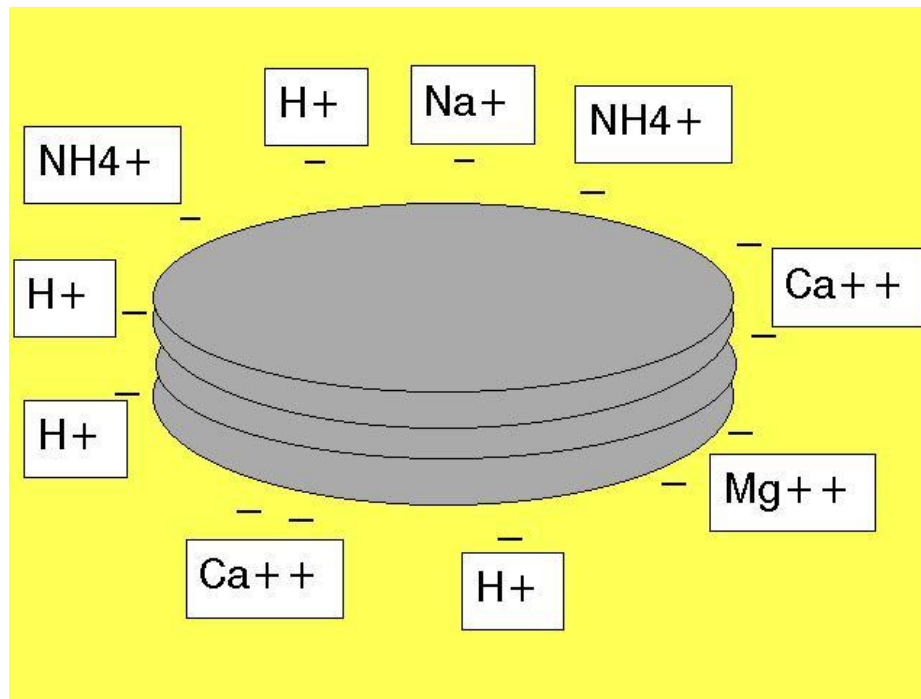
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- Soil Chemical Properties - Organic Matter



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- Soil Chemical Properties - CEC & AEC



CEC: $\text{Al}_3^+ > \text{H}^+ > \text{Ca}_2^+ > \text{Mg}_2^+ > \text{K}^+ \approx \text{NH}_4^+ > \text{Na}^+$

AEC: $\text{PO}_4^{3-} > \text{SO}_4^{3-} > \text{Cl}^- > \text{NO}_3^-$

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- Soil Biological Properties
 - Roots
 - Microflora (bacteria, archaea, fungi, actinomycetes)
 - Microfauna (nematodes, protozoa)
 - Macrofauna (earthworms, rodents)
 - Microbially mediated transformations (C, N, S, P, etc.)
 - Mixing
 - Rhizosphere processes
 - Mycorrhizal symbioses
 - Soil-borne pathogens

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