Chapter 2: Basic Characteristics of Soils

2.1 Soil Formation

Soils are formed from the physical and chemical weathering of rocks. Physical weathering involves reduction of size without any change in the original composition of the parent rock. Chemical weathering causes both reduction in size and chemical alteration of the original parent rock (hydration, carbonation, and oxidation).

Soils that remain at the site of weathering are called residual soils. These soils retain many of the elements that comprise the parent rock. The transported soils may be classified into several groups depending on their mode of transportation and deposition:

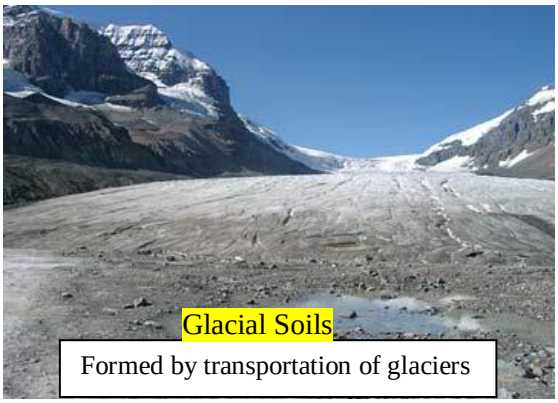
1. Alluvial Soils: transported by rivers and streams.
2. Glacial Soils: formed by transportation and deposition of glaciers.
3. Marine Soils: formed by deposition in the seas.
4. Aeolian Soils: transported and deposited by wind.
5. Gypsum: Calcium sulphate formed under heat and pressure from sediments in ocean brine.
6. Loam: mixture of sand, silt, and clay that may contain organic material.
7. Loess: a windblown, uniform fine-grained soil.
8. Mud: clay and silt mixed with water into a viscous fluid.

2.2 Clay Minerals

The basic structural units of most clay minerals consist of a silica tetrahedron and an alumina octahedron. The basic units combine to form sheet structures (Silica sheet and Alumina or Gibbsite sheet).

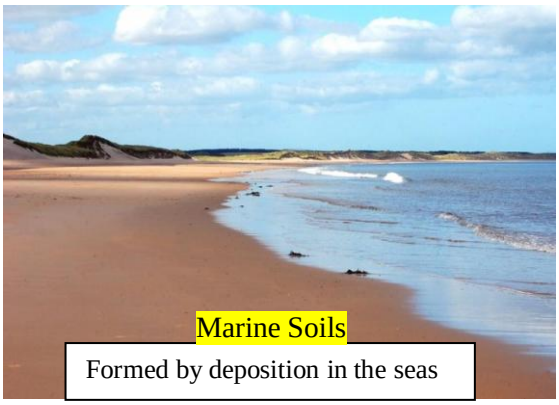
Alluvial Soils

Transported by rivers and streams



Glacial Soils

Formed by transportation of glaciers

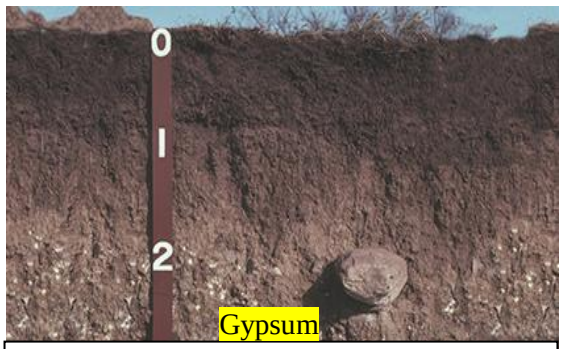


Marine Soils

Formed by deposition in the seas

Aeolian Soils

Transported and deposited by wind



Gypsum

Calcium sulphate formed under heat & pressure

Loam

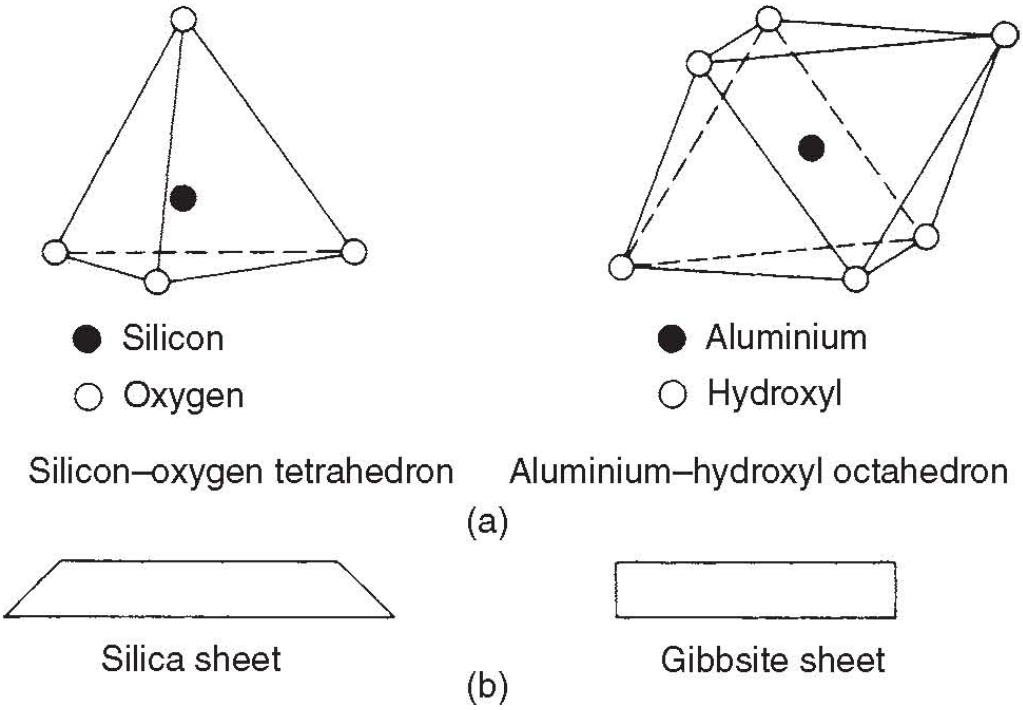
Mix. sand, silt, and clay with organic materials

Loess

Windblown, uniform fine-grained soil

Mud

Clay & silt mixed with water into viscous fluid



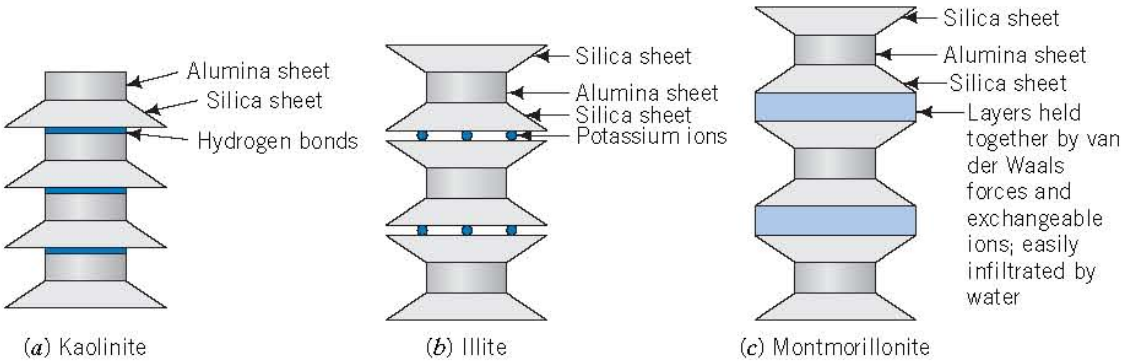
Clay minerals: basic units.

The main groups of crystalline materials that make up clays are:

Kaolinite: Consists of one silica sheet and one alumina sheet. The combined silica-alumina sheets are held together by hydrogen bonding. A kaolinite particle may consist of over one hundred stacks.

Illite: Consists of repeated layers of one alumina sheet sandwiched by two silica sheets. The combined sheets are linked together by weak bonding due to potassium ions held between them.

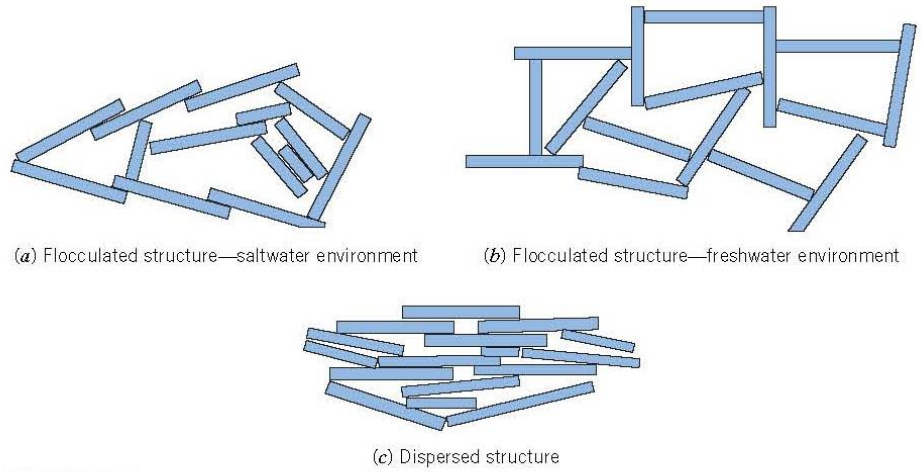
Montmorillonite: Has a structure similar to illite, but the layers are held together by weak van der Waals forces and exchangeable ions. Water can easily enter the bond and separate the layers causing swelling. Montmorillonite is often called swelling or expansive clay.



Structure of kaolinite, illite, and montmorillonite.

2.3 Soil Fabric

During deposition, the mineral particles are arranged into structural frameworks that we call soil fabric. The environment under which deposition occurs influences the structural framework that is formed. Two common types of soil fabric: flocculated and dispersed are formed during deposition of fine-grained soils. A flocculated structure, formed under a saltwater environment, results when many particles tend to orient parallel to each other. A flocculated structure, formed under a freshwater environment, results when many particles tend to orient perpendicular to each other. A dispersed structure occurs when a majority of the particles orient parallel to each other.



Soil fabric.