SOIL SCIENCE……GENERAL AGRIC……..MR. SAKALA J

Soil is defined as unconsolidated mineral or organic or inorganic materials which is formed at the immediate surface of the earth crust. It is a product of the interaction between parent material, climate, organisms, topography (relief) and time (space).

- Soil serves as a source of plant nutrients and provides anchorage to the plants.
- Parent material e.g. consolidated material (rocks, minerals + soils)

- SOIL = F(Parent material, Climate, organisms, Topography and Time)

Weathering

Weathering is the physical breakdown and/or chemical alteration of rocks at or near the Earth's surface can also be defined as the response of rocks to a changing environment. For example, plutonic rocks form under conditions at high pressures and temperatures.

several factors influence the type and rate of weathering.

1. **Climate** - chemical weathering is enhanced in warm, moist climate.
2. **Rock characteristics** - such as chemical/mineralogic composition and the presence of joints. each mineral has a different susceptibility to weathering. For example a granite consisting mostly of quartz is already composed of a mineral that is very stable on the Earth's surface, and will not weather much in comparison to limestone, composed entirely of calcite, which will eventually dissolve completely in a wet climate.
3. **Slope -** On steep slopes weathering products may be quickly washed away by rains. On gentle slopes the weathering products accumulate. On gentle slopes water may stay in contact with rock for longer periods of time, and thus result in higher weathering rates.
4. **Time -** Even under ideal conditions, soil takes thousands of years to develop. Because soil takes so long to form, human activities that damage soils have long-term consequences for ecosystems, and for the utility of the soil for food production.
5. **Animals**- burrowing organisms like rodents, earthworms, & ants, bring material to the surface were it can be exposed to the agents of weathering.

GENERAL TYPES OF ROCKS

1 IGNEOUS

Formed when molten rock (magma or lava) cools and solidifies

When formed inside of the earth, they are called intrusive, or plutonic

If they are formed outside or on Earth's surface, they are called extrusive, or volcanic


Anorthosite


Obsidian


Gabbro


Granite


Pumice


Llanite


Andesite


Scoria


Basalt

2 METAMORPHIC

Formed when an existing rock is subjected to very high temperatures or very high pressures


Gneiss


Anthracite


Schist


Lapis Lazuli


Soapstone


Unakite


Amphibolite


Hornfels


Skarn


Mariposite


Quartzite


Suevite


Marble

3 SEDIMENTARY

Formed through the accumulation and compaction of minerals or organic materials


Dolomite


Tuff


Breccia


Coquina


Caliche


Chert


Oil Shale


Diatomite

Weathering of Common Rocks

Rock	Primary minerals	Residual minerals
Granite	Feldspars	Clay minerals
	Micas	Clay minerals
	Quartz	Quartz
	Fe – Mg minerals	Clay minerals+ Hematite + Goethite
Basalt	Feldspars	Clay minerals
	Fe – Mg minerals	Clay minerals
	Magnetite	Hematite , Goethite
Limestone	Calcite	None
Residual minerals= minerals stable at the Earth surface and left in the rock after Weathering.		

Chemical Weathering involves a chemical transformation of rock into one or more new compounds that are stable at surface conditions.

Chemical weathering also involves putting mineral components into solution - dissolution in water. Water is the most important agent in the three different processes of chemical weathering:

1. **Dissolution**: is a process where a solid dissolves into a solvent such as water forming a solution. Water molecules are polar (bent shape) - oxygen end has slight negative charge and hydrogen atoms have slight positive charge.
2. **Carbonation**- is the reaction of carbonate and bicarbonate with minerals and is a common process helping the breaking down of feldspars and carbonate minerals. Carbon dioxide from the atmosphere and soil air is absorbed by water, to form carbonic acid that acts as a weak acid. Calcium carbonates and magnesium carbonates are dissolved in carbonic acid and are removed in a solution without leaving any residue resulting in cave formation.

3. **Oxidation** :is a chemical process that is responsible for rust forming from iron The oxidation of iron is responsible for many rocks having a rusty red color. In iron-rich minerals such as olivine, the oxidation reaction begins with taking iron out of the mineral and putting it into solution as an ion. **Olivine** reacts with carbonic acid, leaving dissolved iron, bicarbonate, and silicic acid.
4. **Hydrolysis**: is a chemical reaction involving the breaking of a bond in a molecule using water. As an example, feldspars chemically alter (hydrolysis) to form clay minerals such as kaolinite. Typically, natural waters contained some dissolved ions that accelerate the hydrolysis of minerals. Clay minerals are the end products of weathering of many silicate minerals (such as feldspar) and are very stable under surface conditions. Clays make up a major portion of soils and sedimentary rocks such as shale.
5. **Leaching** - ions are removed by dissolution into water.
6. **Dehydration** - removal of H2O or OH- ion from a mineral.
7. **Hydration** - attachment of water molecules to crystalline structure of a rock, causing expansion and weakness.
8. **Chelation**- is a complex organic process by hydrocarbon molecules. Chelation is a form of Chemical weathering by plants. These weathering processes are interrelated. Hydration, carbonation and oxidation go hand in hand and hasten the weathering process

Physical (Mechanical) Weathering involves physical forces that break rock into smaller and smaller pieces without changing the rock's mineral composition (same minerals). It creates broken fragments or “detritus.” which are classified by size:

I. Coarse-grained – Cobbles, and Pebbles.
II. Medium-grained – Sand
III. Fine-grained – Silt and clay (mud).

Four physical processes lead to physical weathering:

1. **Frost Wedging**: is caused by repeated cycles of freezing and thawing. Frost wedging is most prevalent in mountainous regions where there is a daily freeze-thaw cycle. It is frost wedging that causes potholes in roads during the winter.

2. **Unloading (release of pressure):** is a geologic process where overlying rocks at the surface are removed. Rock that form deep in the Earth (like granite) will begin the expand as they reach the Earth's surface (decompression).

3. **Thermal Expansion**: as a weathering process occurs where daily thermal expansion and contraction of individual minerals can exert destructive forces on the cohesion of a rock. This is especially true in desert environments where the change in temperature during the day may be as great as 30°C. This mechanism is probably the least effective of all the weathering processes.

4. **Biologic Activity**: can cause rocks to be broken into smaller pieces. This type of physical weathering can be accomplished by organisms such as trees and burrowing animals. For example, plant roots can grow into fractures, and as they grow larger, they wedge the rock apart.

Biological Weathering: Can be both chemical and mechanical in nature. Roots split rocks apart and roots or organisms produce acids that dissolve rocks. Tree throw, burrowing animals. Unlike physical and chemical weathering, the biological or living agents are responsible for both decomposition and disintegration of rocks and. Biological weathering comprises a group of processes that are caused by, or assisted by, the presence of vegetation, or to a lesser extent animals, including root wedging and the production of organic acids.

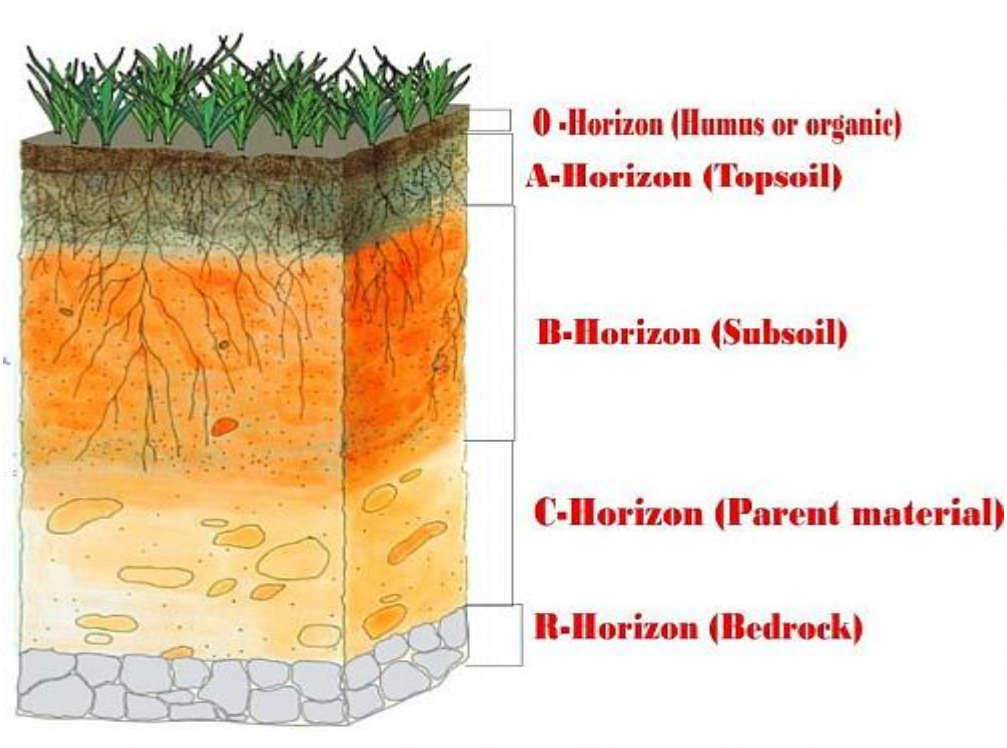
1. **Man and Animals** The action of man in disintegration of rocks is well known as he cuts rocks to build dams, channels and construct roads and buildings. A large number of animals, birds, insects and worms, by their activities they make holes in them and thus aids for weathering. In tropical and sub tropical regions, ants and termites build galleries and passages and carry materials from lower to upper surface and excrete acids

2. **Higher Plants and Roots** The roots of trees and other plants penetrate into the joints and crevices of the rocks. As they grew, they exert a great disruptive force and the hard rock may break apart. (e.g.) pipal tree growing on walls/ rocks. Some roots penetrate deep into the soil and may open some sort of drainage channel.

3. **Role of Micro- organisms** In early stages of mineral decomposition and soil formation, the lower forms of plants and animals like, mosses, bacteria and fungi and actinomycetes play an important role. They extract nutrients from the rock and N from air and live with a small quantity of water.

Soil Profile

Soil Profile is a layer Parallel to the soil surface whose physical, chemical and Biological characteristics differ layer by layer.



O: Decomposed/ undecomposed materials, very intense biological activity

A: leached mineral horizon (dark color) with high content of organic matter **(top soil)**

B: zone of accumulation of fine minerals and mineral precipitates (clay, carbonates, iron, gypsum etc). **Subsoil**

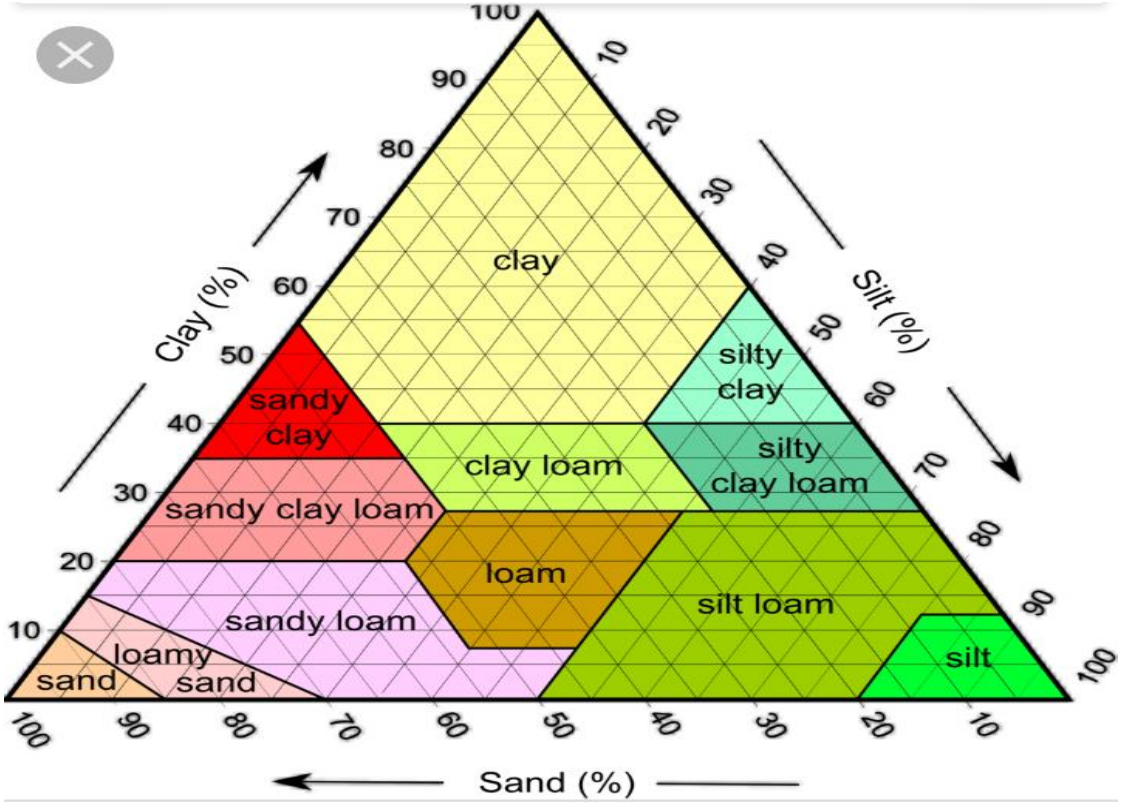
C: Partly weathered rock (rock particles of different sizes)

R: Hard Bedrock (undisturbed or unaltered Rock material)

Soil texture

This is the arrangement of different particle sizes in different proportion of sand, silt and clay.

Loamy soil is an intermediate soil between sand and clay.



TYPE OF SOIL	ADVANTAGES	DISADVANTAGES
SANDY SOIL	I Due to its easy drainage it prevents plants from becoming waterlogged. II It is very easy to dig up or mix around. III It can heat up easily because it is easy to penetrate.	I This soil is poor in nutrients so a lot of plant supplements are required. II Plants that need a lot of water cannot thrive in this soil under dry conditions.
CLAY SOIL	I It is very fertile which is very good for plants. II It retains water and nutrients well.	I Its ability to retain water also causes it to become waterlogged which can damage some plants. II When clay soil heats up it cakes and makes it very hard to dig up or even mix.
LOAMY SOIL	I Rich in nutrients and retains water. II It also drains well preventing waterlog.	I Loam soil with a large amount of sand component is very dry and requires a lot of water for plant growth.