ORIGIN AND FORMATION OF SOIL

“Soil is the fine earth covering land surface that has the important function of serving as a substratum of plant, animal and human life and acts as a reservoir of nutrients and water”. Soil is the material on the earth’s surface that results from the interactions of weather and biological activities with the underlying geologic formation. Soil is produced from broken down rocks, organic matter (decayed animals and plant life), water, and air”.

Pedology is the study of origin, formation and geographic distribution of soils in nature, whereas Edaphology is the study of soils in relation to crop growth.

**Origin of Soil:**

(a) Rocks are the chief sources of soil materials over which soils are formed.

(b) Soil is formed from weathering of rocks.

(c) Disintegration breaks consolidate rocks into unconsolidated parent materials, which on further breaking and chemical decomposition form soil.

(d) Soil found at the site of formation is called sedentary soils, whereas soils found far away from the site of formation are called Cumulous or transported soils.

(e) Physical weathering involves agents such as temperature, water, wind, plant and animals and the process such as surface peeling off of rocks, alternate wetting and drying, freezing and thawing, burrowing of animals root penetration etc.

(f) Chemical weathering involves different reactions i.e. solution, hydration. Hydrolysis, Oxidation and reduction. Hydrolysis is the most important chemical weathering process.

**Soil Weathering and Soil Formation**

Soil formation and development is a dynamic rather than static process. Soils were present when prehistoric animals roamed the Earth and, like those animals, some are no longer present or are preserved only as fossilized soils buried deep beneath our present soil.

Weathering describes the means by which soil, rocks and minerals are changed by physical and chemical processes into other soil components. Weathering is an integral part of soil development. Depending on the soil-forming factors in an area, weathering may proceed rapidly over a decade or slowly over millions of years.

The development of a soil reflects the weathering process associated with the dynamic environment in which it has formed. Five soil-forming factors have been identified that influence the development of a specific soil. Wherever these five factors have been the same on the landscape, the soil will be the same. However, if one or more of the factors differ, the soils will be different. The factors are.....

1. Parent material

2. Climate

3. Living organisms

4. Topography

5. Time

Parent Material

Parent material is made of rock and minerals. When the other four soil-forming factors act on parent material, it is weathered into smaller particles forming soil.

There are many types of parent material with different mineral contents. The Earth is believed to be about three billion years old. Mountains have been created and eroded away and then created again. Seas have covered the land and receded leaving layers of mud, sand and lime carbonate thousands of feet thick. Volcanoes have erupted. Glaciers have formed during long periods of cold weather and melted during long periods of warm weather.

Parent material can be rock formed in place or the remnants of rock that was moved by wind, water, ice or even gravity.

Geologic materials moved from the parent material by water are known as alluvium. Alluvial deposits are found in flood plain areas such as the Platte River and other stream valleys. Since stream beds constantly change over time, alluvial parent materials are highly variable as are the soils that form them.

The physical and chemical weathering processes that change parent material into soil include:

• Temperature changes — freezing and thawing.

• Erosion by water, wind, ice and gravity.

• Roots of plants, burrowing animals, insects and microorganisms.

• Water relations — wetting and drying.

• Changes in chemical composition and volume.

Physical processes primarily result in the breakdown of rocks into smaller and smaller particles. As the particles become smaller, various living organisms begin to have a great impact on soil formation because they contribute organic matter. In addition, the smaller particles speed chemical processes which result in new chemical compounds. All of these processes are greatly influenced by climate, especially temperature and precipitation.

Climate

The amount of water entering a soil influences the movement of calcium and other chemical compounds in the soil. Ultimately, if more chemicals are removed, the soils will be deeper and more developed. Precipitation influences vegetation and, therefore, greatly determines the organic matter content of soils. Higher temperatures can speed the rate of organic matter decomposition.

Living Organisms

The most abundant living organism in the soil is vegetation. Vegetation influences the kind of soil developed because plants differ in their root systems, size, above ground vegetative volume, nutrient content and life cycle. Soils formed under trees are greatly different from soils formed under grass even though other soil-forming factors are similar. Trees and grass vary considerably in their search for food and water and in the amount of various chemicals taken up by roots and deposited in or on top of the soil when tree leaves and grass blades die.

Soils formed under grass are much higher in organic matter than soils formed under forests because of their massive fibrous root structure and annual senescence of above ground vegetation. Grassland soils tend to be darker, particularly to greater depths, and have a more stable structure than forest soils. Soils developed under grass are generally more fertile and best suited for crop production. Nebraska soils from any parent material are nearly all formed under grass and, with adequate water, can be very productive. The kind of plant growing influences residue composition. For example, the decay products from conifer tree needles are different from those of hardwood tree leaves. These decay products affect soil formation and development differently when water moves them through the soil.

The kind of vegetation and climate also affects the kind and numbers of other organisms that live in the soil, such as insects, small animals, and microorganisms. Organisms chew, tear and digest plant and animal material, causing it to undergo further biochemical action as it decays. Nondecomposed plant and animal material may be consumed by some organisms while others feed off of organism excrements. There are a multitude of organisms living in the soil. Included among them are mites, snails, beetles, millipedes, springtails, worms, ground squirrels, gophers, grubs, nematodes, and microorganisms (e.g., bacteria, fungi, actinomycetes and algae). Microorganisms are the most abundant organisms in the soil.

The activity of soil organisms is strongly influenced by soil temperature, acidity and soil-water relations. Their major contributions to soil are improved soil structure, nutrient transformations and fertility, aeration and enhanced productivity. Under forests, soil microorganisms are more diverse than under grasslands; however, microorganisms under grasslands are more active and have greater mass than under forest conditions. In general, cultivated fields have fewer organisms than virgin areas. A generalized ratio for the mass of organisms under grass/meadow:oak forest:spruce forest is 13:5:1.

Among soil organisms, bacteria are most abundant followed by actinomycete (rod-shaped microorganisms) and earthworms. As much as 4,000 pounds of bacteria can be present per acre-furrow slice (furrow slice = a 6-inch depth of soil). This is more than four times the mass of earthworms that can be present. Because of the quantity of organisms present in the soil and their ability to accelerate the decay of organic material, they play a major role in soil formation.

Topography

Variations in topography affect moisture and temperature relations. Each of these topographic regions has some common features which affect soil formation.

On a local scale, we can compare a nearly level field with one that is hilly. The steeper the slope, the more influence topography has on soil development on hills and steep land. Runoff is accelerated on sloping land, so less water infiltrates the soil. Plants, therefore, tend to have shallower root systems; and less organic matter is produced, as compared to nearly level land. Steep slopes are also subjected to more erosion which removes soil as fast, or faster, than it forms. On nearly level land, water tends to pond on the soil surface. Here, plant growth may be prolific, resulting in the production of large amounts of organic matter.

Slopes with a southern exposure are warmer and drier than slopes with a northern exposure. In fact, topography affects the micro-environment for soil formation in a manner similar to climate’s affect on macro environment for soil formation.

Time

Soils have been referred to as young, mature, and old, depending on the degree of weathering. A mature soil is in equilibrium with its environment and shows full development of layers or horizons in its profile.

Soils probably never reach equilibrium, but they do get older and are weathering all the time. The rate of weathering, however, slows considerably as the soil nears equilibrium with its environment. The longer a parent material has been exposed, the greater the degree of weathering and the more developed the soil.