SOIL FORMATION – Part-1

Introduction

Soil is a mixture of minerals, organic matter, gases, liquids and countless organisms that together support life on Earth. Soil is a natural body called the pedosphere and has several important functions. It is a medium for plant growth and also a means of storage, supply and purification of water. Soil is called the "Skin of the Earth" and interfaces with the lithosphere, hydrosphere, atmosphere and biosphere.

The soil formation process is termed 'pedogenesis'. Climatic conditions are important factors that affect both the form and rate of physical and chemical weathering of the parent material of soil. The study of soils as naturally occurring compounds is called ‘pedology’, and a person who studies soils is called a ‘soil scientist’ or ‘pedologist’.

Soil Profile

Various layers of soil types can be seen when we dig a massive shaft about 50-100ft vertically downwards into the ground. The layers give a cross-section view of the ground. This cross section view is called a ‘Soil Profile’. The profile is made up of layers, running parallel to the surface, called ‘Soil Horizons’. Each horizon may be slightly or very different from the one above or below it. Each horizon shows the makeup, age, texture and characteristics of that layer.

Most soils have three major horizons. These are: A-Horizon, B-Horizon and C-Horizon. Apart from these three, there are also the O-Horizon, E-Horizon and R-Horizon.

- **O-Horizon**: The O-Horizon is very common and has a lot of vegetative cover. It is the layer made up of organic materials such as dead leaves and surface organisms, twigs and fallen trees. It has about 20% organic matter. This horizon is often black or dark brown in color, because of its organic content. It is the layer in which the roots of small grass are found.

- **A-Horizon**: The A-Horizon may be seen in the absence of the O-Horizon, usually known as the 'top soil'. It is the top layer soil for many grasslands and agricultural lands. Typically, they are made of sand, silt and clay with high amounts of organic matter. This layer is most vulnerable to wind and water erosion. It is also known as the 'root zone'.
- **E-Horizon**: The E-Horizon is usually lighter in color, often below the O and A-horizons. It is rich in nutrients that are leached from the top A and O-Horizons. It has a lower clay content and is common in forest lands or areas with high quality O and A-Horizons.
- **B-Horizon**: The B-Horizon has some similarities with the E-Horizon. This horizon is formed below the O, A and E-Horizons and may contain high concentrations of silicate clay, iron, aluminum and carbonates. It is also called the 'illuviation zone' because of the accumulation of minerals. The roots of big trees end in this layer of soil.
- **C-Horizon**: The C-Horizon lacks all the properties of the layers above it. It is mainly made up of broken bedrock and no organic material. It has cemented sediment and geologic material. There is little activity here although additions and losses of soluble materials may occur. The C-Horizon is also known as 'saprolite'.
- **R-Horizon**: The R-Horizon is bedrock, material compacted and cemented by the weight of the overlying horizons. It is the unweathered parent material. Rock types found here include granite, basalt and limestone.

Formation of Soil

Soil is formed from rocks. On the basis of formation, rocks are of three types - igneous rocks, sedimentary rocks and metamorphic rocks.

1. **Igneous Rocks**: Igneous rocks are formed by the cooling of earth's liquid magma. A variety of igneous rocks is formed according to the chemical composition of the magma and its rate of cooling. For example, Granites are formed by cooling of magma and it is high in silica. In contrast, basalts formed from magma are low in

silica; they contain minerals such as amphiboles, pyroxenes and olivines. The crystal size is small because the magma cools rapidly.

2. **Sedimentary Rocks**: Sedimentary rocks are the product of weathering and erosion. So, they have therefore gone through at least one weathering cycle. They can be described as sand stones, siltstones or clays.

3. **Metamorphic Rocks**: The third group is called metamorphic rocks. High temperatures and pressures cause some degree of recrystallisation of sedimentary rocks, converting sand stones into quartzite and clays into slate.

Soils are formed from all the three groups of rocks.

Processes of Soil Formation

There are five key processes by which soil is formed. They are leaching, eluviations, illuviation, podsolisation and gleying.

Leaching - Leaching is the removal of soluble components of the soil column. As water washes down through the soil it carries away bases such as calcium, which are held as exchangeable ions in clay-humus complexes.

Eluviation - In eluviation soil particles held in suspension, such as clay, are removed or washed away.

Illuviation - In illuviation soil particles held in suspension, such as clay, are accumulated or deposited.

Podsolisation - Podsolisation occurs when strongly acid soil solutions cause the breakdown of clay minerals. As a result silica, aluminium and iron form complexes with organic substances in the soil. These minerals are removed from the surface zone of the soil and can accumulate in distinct dark sub-surface layers.

Gleying - Gleying occurs in waterlogged, anaerobic conditions when iron compounds are reduced and either removed from the soil, or segregated out as mottles or concretions in the soil. Marshy wetlands often contain gleyed soils.

Factors Affecting Soil Formation

Various factors affect soil formation. These are: parent material, time, climate, relief and organisms.

- **Parent Material**: 'Parent Material' refers to the mineral material, or organic material from which the soil is formed. Soils will carry the characteristics of their parent material such as color, texture, structure, mineral composition and so on. For example, if soils are formed from an area with large rocks (parent rocks) of red sandstone, the soils will also be red in color and have the same feel as the parent material.
- **Time**: Soils can take many years to form. Younger soils have some characteristics from their parent material, but as they age, the addition of organic matter, exposure to moisture and other environmental factors may change their features. With time, soil particles settle, are buried deeper below the surface, and transform. In this way soils may change from one soil type to another.
- **Climate**: Climate is probably the most important factor that can affect the formation of soils. Two important climatic components are temperature and precipitation. They determine how quickly weathering will occur, and what kind of organic materials may be available on and inside the soils. Moisture determines the chemical and biological reactions that will occur as the soils are formed. Warmer climate with more rainfall means more vegetative cover and more animal action. It also means more runoff, more percolation and more water erosion.
- **Relief**: 'Relief' refers to the landscape position and the slopes it has. Steep, long slopes mean water will run down faster and potentially erode the surfaces of slopes. The effect of this is the presence of poor soils on the slopes, and

richer deposits at the foot of the slopes. Also, slopes may be exposed to more direct sunlight, which may dry out soil moisture and render it less fertile.

- **Organisms:** The source and richness of organic matter is due to the living things - plants and animals that live on and in the soils. Plants in particular, provide lots of vegetative residue to soils. Their roots also hold the soils and protect them from wind and water erosion. They shelter the soils from the sun and other environmental conditions, helping the soils to retain the needed moisture for chemical and biological reactions. Fungi, bacteria, insects, earthworms and burrowing animals help in soil aeration. Worms help in breakdown of organic matter and aid in decomposition. Animal droppings and bodies of dead insects and animals result in more decaying organic matter. Microorganisms also help with mineral and nutrient cycling and chemical reactions.

Conclusion

In this interaction we have learned about soil, its various profiles and the processes involved in its formation. We have also discussed the factors affecting soil formation.

In our next interaction we will deal with the types of soil, the various physical and chemical properties of soil and its importance.