**Process of Soil Formation**

Soil formation or pedogenesis is the process of evolution of soil under the influence of various physical, biological, climatic, and geological factors. Soil formation occurs via a series of changes to the parent material, all of which lead to the formation of layers of soil, also called soil horizons. These layers can then be separated on the basis of the composition and other physical properties.

Factors affecting Soil Formation

Soil forms continuously, but slowly, from the gradual breakdown of rocks through weathering. Weathering can be a physical, chemical or biological process:

physical weathering—breakdown of rocks from the result of a mechanical action. Temperature changes, abrasion (when rocks collide with each other) or frost can all cause rocks to break down.

chemical weathering—breakdown of rocks through a change in their chemical makeup. This can happen when the minerals within rocks react with water, air or other chemicals.

biological weathering—the breakdown of rocks by living things. Burrowing animals help water and air get into rock, and plant roots can grow into cracks in the rock, making it split.

The accumulation of material through the action of water, wind and gravity also contributes to soil formation. These processes can be very slow, taking many tens of thousands of years. Five main interacting factors affect the formation of soil:

* parent material—minerals forming the basis of soil
* living organisms—influencing soil formation
* climate—affecting the rate of weathering and organic decomposition
* topography—grade of slope affecting drainage, erosion and deposition
* time—influencing soil properties.
* Interactions between these factors produce an infinite variety of soils across the earth’s surface

**A. Parent material**

Parent material refers to the initial solid matter that makes up the soil. Parent material might include consolidated substances like rocks or unconsolidated particles like water deposits, volcanic ashes, or organic matter. The composition of the parent material affects soil formation as it determines the soil composition; for example, iron-containing rocks usually result in iron-rich soil which has higher pH and darker color.

Usually, parent materials are collected via wind, water, and volcanoes, resulting in differences in the initial composition of the rock. The influence of parent material can also be observed in adjacent soils that frequently exhibit different soil profile due to different parent materials. Changes in the parent material during soil formation can be either abrupt or subsequent over a long period.

**B. Topography**

Topography in the soil formation process includes factors like the geological structure of the elevation above the sea level, configuration, and the slope. The position of parent material or soil during pedogenesis influences the hydrologic cycle, transpiration, and other such processes. It has been observed that soil profiles on the convex slopes are usually more shallow with less distinct sublayers than the soils on the top of the concave slopes.

However, organic matter of the soil at lower slopes is higher due to runoffs than the soils at higher slopes. Topography might be susceptible to changes over time by processes like soil erosion and earthquakes, which then affects the process of soil formation.

**C. Climate**

Climate as a factor of pedogenesis refers to the weather as the soil evolves over long time scales. These properties might include rainfall, temperature, and storm patterns. The direct effect of climate on soil formation is via water and solar energy. Water is a medium for the life cycles of various soil organisms, whereas sunlight affects the concentration of water on the soil. The effect of climate on soil formation can be clearly seen in the case of desert soils that are usually present around the equatorial region with high solar and water energy. In the temperate regions, however, the climate is humid, which results in tropical soil with sufficient moisture.

**D. Organisms**

The process of soil formation is heavily influenced by the animal inhabitants, the human population, and vegetation. In the case of effects caused by vegetation, it has been observed that soils present under tress tend to more acidic and contain much less humus than those under grass. These differences are observed due to the differences in the litter produced by the two different types of vegetation.

Human beings also affect pedogenesis by either removal or burial of soil profile during construction works or the modification of organic matter by agriculture or irrigation. Soil animals and microorganisms affect soil formation as they influence the organic content of soil and the texture due to their metabolic and physical activity.

**E. Time**

Even though factors like topography and parent materials are site-related, factors like climate and organisms are flux-related, i.e. input from the surrounding. Time is a factor that is neither dependent on the site or the flux but can bring significant changes abruptly. Time, as an independent factor, however, is considered an abstract variable that shows that the evolution of soil might change without any external inputs. The effects of time on the soil profile can be observed by the composition of the soil where the accumulation of clay and lime in the sublayers occurs due to downward translocation. The humus content in the soil horizons might also differ with aging.

**Soil Formation process or steps**

The soil formation process begins with a parent material that determines the mineral composition and widely contributes to the chemical and physical properties of the soil. There are several ways or mechanisms involved in soil formation;

**A. Weathering**

Weathering is the breakdown of rocks and minerals at or near the Earth’s surface into products that result in equilibrium with the conditions found in this environment. The products of weathering are the major source of sediments for erosion and deposition.The process of weathering can occur either via physical, chemical, or biological weathering processes.

Physical weathering results in the breakdown of mineral or rock material by entirely mechanical methods brought about by a variety of causes. Abrasion of large rocks occurs when some forces cause two rock surfaces to come together, causing mechanical wearing or grinding of their surfaces.

Chemical weathering is the alteration of the chemical and mineralogical composition of the weathered material via chemical means. A number of different processes, including hydrolysis, oxidation, reduction, hydration, carbonation, and solution result in chemical weathering.

Biological weathering involves the disintegration of rock and mineral due to the chemical or physical agents of an organism. The organisms that can cause weathering might range from bacteria to plants to animals.

**B. Accumulation of materials**

Materials such as organic matter and decomposing materials or new mineral materials are added to the soil by the forces of ice, water, or wind and they accumulate over time. In the case of poorly drained soils, the organic matter accumulates since water-logging prevents it from being oxidized or broken down by soil organisms. However, in the case of well-drained soils, the accumulation of materials occurs when the root systems hold them up.

Particle depositions by the forces of wind, water, or ice equally aid in the accumulation of new materials. Some plants with the help of symbiotic bacteria fix atmospheric nitrogen and ammonia compounds into the soil as nitrates.

C. Leaching

Leaching is the removal of soluble components of the soil column by water. The water washing down through the soil carries bases like calcium, held as exchangeable ions in clay-humus complexes, as well as acidification by the substitution of hydrogen ions.Through the movement of water, wind, ice, or by the uptake of the accumulated materials by plants, new particles including clay, organic matter, clay, silt, or other chemical compounds get leached and eroded or taken up by plants.

Thus, the physical and chemical compositions of the new accumulated materials together with the soil parent material are altered.

**D. Transformation**

Transformation is the chemical weathering of soil particles, including silt, sand, and clay minerals as well as the change of organic materials into degradation-resistant organic matter. Following transformation, the clay and other accumulated materials are washed from the upper layer and deposited in the lower horizons. The soil organisms like plants and animals are also responsible for the transformation of the soil by the physical and chemical breakdown of the materials.

The soil begins to take shape on its own through transformation, which improves water retention capacity and nutrient composition.

**E. Calcification**

Calcification occurs when the removal of water via evapotranspiration exceeds precipitation causing the upward movement of dissolved alkaline salts from the groundwater. Meanwhile, the movement of rainwater causes a downward movement of the salts.