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TO STUDY OF SOIL FORMATION AND WEATHERING PROCESS WITH SPECIAL REFERENCE TO SOIL EROSION IN INDIA

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ABSTRACT

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 which has four important functions: it is a medium for plant growth; it is a means of water storage, supply and purification; it is a modifier of Earth's atmosphere; it is a habitat for organisms; all of which, in turn, modify the soil.

KEYWORDS: *Soil, Physical weathering, Biological weathering, Physical weathering, Chemical weathering.*

I)INTRODUCTION

It is the shallow body of material found on the surface of the land, derived directly or indirectly from weathered mantle rock in association with organic detritus, water, air and living organisms. Soil is the habitat of microorganisms and burrowing animals. Moreover, it supplies materials to indwelling members of the biota.

FORMATION – PROCESSES

We know that there are three kinds of soil-forming rocks, viz. igneous rocks, sedimentary rocks and metamorphic rocks. Soil formation results from the disintegration or weathering of parent rocks by physical, chemical or biological agents. As a result, small particles called regohths are formed. Regoliths under the influence of other pedogenic processes finally develop into mature soil. Following are the processes of soil formation discussed here in detail.

(I) Physical weathering. When climatic agents such as temperature, water, ice, and gravity change the rocks in regoliths but do not cause any chemical transformation of rocks, the process is called as physical weathering. It occurs in deserts, at high altitudes and latitudes specially at places where sparse vegetation grow over the rocks.

(ii) Chemical weathering. Due to physical weathering, rocks are exposed to chemical weathering that occurs simultaneously and continues for a long period after that. Here the chemical transformation of parent minerals occurs to form new mineral complexes. Water is the most potent weathering agent. Soluble rocks like gypsum, limestone and those with a calcareous content get weathered by the solvent action of water. Hydrolysis allows the exchange of constituent parts between water and minerals. As a result, hydroxides of iron, magnesium, calcium and aluminium are formed. The release of calcium, magnesium, potassium and sodium as well as hydrations further contribute to chemical weathering.

(iii) Biological weathering. Certain organisms like bacteria protozoans, fungi and nematodes as well as lichens and mosses colonize at the rocks and transform it into a dynamic system storing energy and synthesizing organic material. Their activities change the physical structure of the rock. The lichens and mosses extract mineral nutrients such as P, S, Ca, Mg, K, Na, Fe, Si and Al'from the rock. They combine with organic matter and eventually return to the developing soil after the decomposition of vegetation.

WEATHERING PROCESSES

Weathered rocks are changed into regohths that are again changed into soil. Thus weathered material undergoes a number of complex processes collectively known as pedogenesis. Pedogenesis is by and large a biological phenomenon. During this process, living organisms such as bacteria, fungi, algae and lichens, insects and molluscs contribute to different geochemical, biochemical and biophysical reactions, viz. CO_2 production, secretion of organic acids, secretion of enzymes and addition of organic matter after death. These activities convert the weathered earth crust into true soil consisting of mineral matrix in association with a variety of organic compounds rich population of microorganisms. The process, being coll keeps on adding to the developing soil, organic matter and the form of layers. Different elements found in the soil can be alchemically classified as:

1. Siderophiles that is associated with iron
2. Chalcohiles that is associated with sulphide minerals
3. Lithophiles that tend to be associated with oxide ion
4. Atomophiles that tend to occur as gaseous components of the atmosphere

Therefore the soil when fully developed can be observed having a number of horizons, starting from surface to downwards. These horizons make a soil profile which has been dealt with separately in this chapter.

Soil Types

The soil formed after the weathering of soil forming rocks is called embryonic or primary soil. It may mature into following types of soils.

(i)Residual or sedimentary soil. It is the mature soil lying immediately over the parent rocks.

(ii)Immature soil. It is the partly weathered material that is why it is called as immature soil.

(iii)Secondary or transported soil. When the weathered parent material is shifted to different places through different agencies, it is called as secondary or transported soil.

Soil Classification

Soil scientists classify soil into different types according to their physical and chemical properties. The classification is useful for agriculture purposes. The methods of soil taxonomy or seventh approximation divide the soil into following orders.

Entisols. They are often young soils. There is no horizon development. Many are recent alluvium including the synthetic soils.

Vertisols. Regions having pronounced wet and dry climate contain this type of soil. They expand and contract with changing moisture. They include swelling clays.

Inctpttaola. They are mostly found in humid climates but may uud from Arctic to Tropics. Native vegetation is most often a forest. They have appreciable accumulation of organic material. Horizons are not well differentiated.

Aridosols. They are found in dry places and deserts. Organic is low. Subsoil horizon contains gypsum or calcium carbonate. Other materials may also accumulate.

Mollisols. They are commonly found in semi-arid or subhumid are characterized by black organic rich 'A' horizons. Surface horizons are also rich in bases. They are also known as prairie soils.

Spodosols. These soils are specially found under the forests in They are characterized by ash coloured sands over are acid soils commonly formed from the sandy parent do contain amorphous materials like iron aluminium seqsquoxides and humus.

Alfiols. They are commonly found under forests in humid regions of the mid latitude. They contain a brown or gray brown surface tub soil containing a sum of cations such as calcium, sodium and magnesium.

Ulfisols. They are restricted to humid climates and form on older are characterized by argilhc horizon with low base ally red-yellow or reddish brown in colour.

Oxisols. They are found in tropical and sub-tropical regions. They eless and contain leached, hydrated, deep soils rich I and aluminium.

Histosols. Organic soils (peat, muck, bog).

The important ecological soil properties for planning are physical and organic contents, all of which affect the and nutrients. The more important properties of soil for planning are strength, sensitivity, compressibility, erodibility, permeability or drainage potential, corrosion potential, ease of excavation and a shrink/swell potential.

Soil Profile

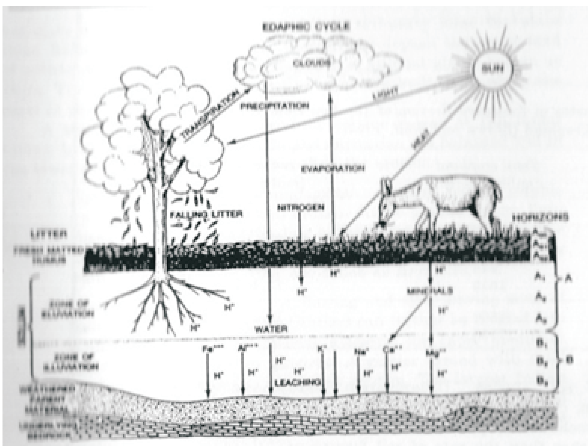
A part of the soil that develops characteristic physical and chemical properties is called a soil horizon, taken together in natural seqaence from surface to downward; these horizons make a soil profile. However, soil horizons develop together as a harmonius system. The different horizons are in direct contact with their immediate neighbours and are easily influenced by them. The soil profile evolves from different layers of stratified or unstratified material mechanically superimposed on one another as well as from the underlying rock. The most obvious physical characters that differentiate the soil horizons are structure, consistency, porosity, texture and colour. In general, soils have the following horizons.

(i)O Horizon. The uppermost horizon of soil profile is called O. horizon or litter zone. It is present in the soil of forests but absent in deserts, grasslands and cultivated fields. It is further divided into two sub layers.

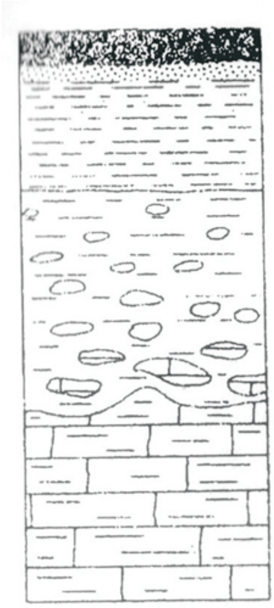
O_1 horizon or Ao horizon. It is the top layer of soil that contains loose levels and organic debris which are largely undercomposed.

O_2 horizon or Ao horizon. O_2 horizon underlies the O_1 horizon and contains partly decomposed organic debris. The upper portion of this horizon is partially decomposed and called as duff. Lower part of this horizon is completely decomposed and is called a humus. It is the habitat of small animals.

(ii) A Horizon. It is present under the litter zone and is called as top-soil. It is the zone of eluviation that contains a relatively high content of organic matter but mixed with mineral matter. It is further divided into three subzones.



A : Sketch showing the edaphic cycle of a mature soil Including Circulation of energy, minerals and organic matters.

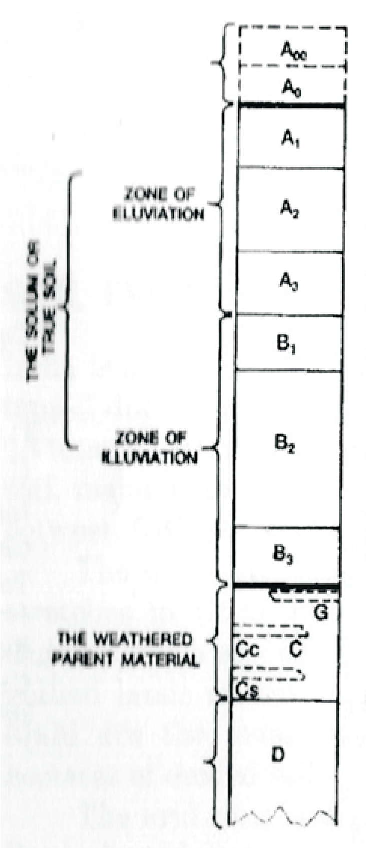


A. Horizon (top soil) Upper part Is rich In organic matter. Lower portion is the zone of leaching.

B. Horizon (sub soil) Zone of illuviation.

C. Horizon partially altered parent material.

B : A soil profile showing A, B and C horizon



Loose leaves and organic debris, largely undecomposed.
Organic debris partly decomposed or matted; frequently divided Into sub-horizons.
A dark-colored horizon, containing a relatively high content of organic matter, but mixed with mineral matter. Thick in prairie and thin in forest soil.
A light-colored horizon, often representing Uie zone of maximum leaching (or reduction). Absent in prairie and some other soils.
Transitional to B, but more like A than B. Sometimes absent.
Transitional to A, but more fike B trian A. Sometimes absent.

A-usually deeper-colored horizon, often representing the zone of maximum receipt of transported colloids. Often transitional to C, with definite structure, but not hardened.
Transitional to C.
G represents the glei layer of the intrazonal soils'of the humid region.
Cc and Ci represent possible layer of accumulated calcium carbonate or calcium sulphate found in prairie and other soils; usually occurring between 8 and C.
Underlying stratum.
Important subdivisions of the main horizons are conveniently indicated by extra numerals thus; A2 , And A2 represents subhorizons winthin A2.

C: Schematic arrangement and nomenclature of horizons in the soil profile (Redrawn from the U.S. Department of Agriculture, Yearbook of Agriculture, 1938.)

A1 horizon. Humus and minerals mix in this zone and bacteria and fungi inhabit this layer.
A2 horizon. It contains less humus and is called as the zone of maximum leaching because silicates, oxides of iron and aluminium are removed at the highest rate.
A3 horizon. It is transitional to B zone but is more like the A zone than B. Sometimes it is totally absent.
(iii) B Horizon. It is the subsoil, a zone where the materials leached out from A horizon are precipitated and enriched. That is why it is also called as the zone of illuviation. It is deep coloured and represents the zone of maximum receipt of transported colloids.
(iv) C Horizon. B horizon underlies the weathered rock or sediment that serves as the parent material for the mineral fraction of the soil. It is called as the C horizon or regolith.
(v) D Horizon. Unweathered bedrock forms the D horizon, sometimes also called as B horizon. Much of the rich soil in the 'granaries of the world' has been transported and deposited by wind (Hobbs, 1943).

Soil Erosion in India

India is one of the few countries in the world to have estimated loss of topsoil due to erosion. Roughly about 5,300 million tonnes of soil (about 16 tonnes/hectare) is being eroded every year hi the country. Alongwith soil, major plant nutrients (nitrogen, phosphorus and potash) ranging between 5.37 and 8.4 million tonnes are also lost.

The worst and most serious form of land erosion is plaguing vast stretches in Uttar Pradesh, Madhya Pradesh, Bihar, Rajasthan and Gujarat which account for 3.3 million hectares. The highly eroded deep gullied lands on the banks of big rivers like Yamuna, Chambal and Mahi are the most spectacular ravines that account for 4 million hectares of eroded soil.

The arid zone is distributed in Gujarat, Punjab, Haryana, Andhra Pradesh and Karnataka. An area of 23,882 sq. km. in Rajasthan is threatened by the spread of desert. Of this, 4.34 per cent is mostly concentrated in the extreme west in Jaisalmer district. About 76.15 per cent of the area forming a belt in Ganganagar, districts is considered to be 'high to medium' in susceptibility to erosion whereas remaining 19.5 per cent is found to be 'medium to slight' in the degree of degradation.

In peninsular India, soil erosion is widely prevalent in the western Ghats. The extensive clearing of forests in the unprotected catchments and intense human and livestock interference with the vegetation in the hill slopes have aggravated the problem. In the Nilgiris district, about 68,000 hectare of land have been affected by severe soil erosion. Mountain sides of Kerala are also facing soil erosion. The widespread cultivation of the erosive crop, Tapioca, has caused havoc. Deforestation is rampant and consequent situation is a big problem in many dams hi the state.

Rains also contribute in the process of soil erosion. They have been eroding Kerala coast. The coastal line suffers erosion during monsoon when the Arabian sea is very rough. 560 km long coastline of Kerala is subjected to sea erosion. The grave environmental damage to the hills have given rise to people's movements such as Chipko Movement in Uttaranchal and Appiko Movement hi Western Ghats. The Central Soil and Water Conservation Research and Training Institute, Dehradun and Central Arid Zone Research Institute at Jodhpur are working hard to protect these fragile ecosystems. They could be restored to original state over the years if human interface is totally stopped. It has been demonstrated by SABARIGIRI site which was abandoned after construction. It now supports lush forests and wildlife.

CONCLUSIONS

Soils that exist at the Weber Farm Site today began forming at the end of the Ice Age, about 13,000 years ago. They formed in loess-derived silty parent material and sandy material derived from the underlying weathered sandstone bedrock. Climatic conditions and native vegetation, when considered as soil-forming factors, are essentially constant across the site except as a function of slope steepness and slope aspect. South and west facing portions of the study area receive somewhat more direct sunlight and north-facing portions of the study area receive somewhat less direct sunlight. The affect of this difference was not addressed in this study. However, it is likely that soils on south and west facing slopes in the study area exhibit higher soil temperatures, a longer frost-free season, and reduced soil moisture during the growing season, and soils on north facing slopes in the study area exhibit lower soil temperatures, a shorter frost-free season, and increased soil moisture during the growing season.

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