MASTER HORIZONS

Horizontal layers of soil called horizons can be described by their different morphological characteristics. Capital letters designate master horizons, which are further subdivided by Arabic numerals.

O Horizon : O horizon is an organic horizon. It is a surface layer characterized by accumulation of organic matter which may be dominated by partially decomposed or undecomposed organic material.

A Horizon : The A horizon is the uppermost mineral layer. It may lie below the O horizon. An A horizon has a high concentration of humus and it is usually regarded as an elluvial surface horizon.

E Horizon : The E horizon is an elluvial surface horizon. It has experience the loss of clay, organic matter, iron and aluminum oxides with the resultant accumulation of quartz and other resistant minerals. It is also characterized by bleached appearance because of loss of materials.

B Horizon : The B horizon is a subsurface mineral horizon showing evidence of illuvial accumulation of silicate clay, iron, aluminum, gypsum, or silica; carbonate removal; residual concentration of sesquioxides and silicate clay; coating of sesquioxides, (etc.).

C Horizon : The C horizon is a layer of minimal alteration. Material may be similar to or unlike that from which the other horizons formed.

R Layer: An R layer refers to hard consolidated bedrock. The R layer is presumed to be the material from which the overlying horizons are developed. But if it is a different material from that of the overlying mantle, it is represented by IIR, indicating what is called LITHOLOGICAL DISCOUNTINUITY.

TRANSITIONAL HORIZONS

Transitional horizons are dominated by properties of one master horizon but have the subordinate properties of another. These are designated by two capital letters, for example, AB, EB, BE, or BC. The first letter represents the dominant horizon characteristics.

SUBORDINATE DISTINCTIONS

Master horizons are further divided by subordinate characteristics, which usually do not apply to transitional horizons. Subordinate distinctions are identified by lower-case letters, called suffix symbols.

- ***a.*** *Highly decomposed organic material.* ***b****. Buried genetic horizon.* ***c.*** *Concretions or nodules.* ***d****. Physical root restriction.* ***e.*** *Organic material of intermediate composition.* ***f.*** *Frozen soil.* ***g****. Strong gleying.* ***h****.* I*lluvial accumulation of organic matter.* ***i****. Slightly decomposed organic matter.* ***k****. accumulation of carbonates.* ***m****. cementation or induration,* *km* . Cementation by carbonates; *qm* . Cementation by silica; *sm*. Cementation by iron; *ym*. Cementation by gypsum; *kqm*. Cementation by lime and silica; and *zm*. Cementation by salts more soluble than gypsum. ***n****. Accumulation of sodium.* ***o****. Residual accumulation of sesquioxides* ***p****. Tillage or other disturbance.* ***q****. Accumulation of silica.* ***r****. Weathered or soft bedrock.* ***s****. illuvial accumulation of sesquioxides and organic matter.* ***ss*** *. Presence of slickensides* ***t*** *. Accumulation of silicate clay* ***v*** *. plinthite.* ***w****. development of color or structure.* ***x****. fragipan character.* ***y****. Accumulation of gypsum* **z** *. accumulation of salts more soluble than gypsum*

DIAGNOSTIC HORIZONS:

Master horizons describe a soil profile, while diagnostic horizons are used to classify soils. Whereas master horizons are based on appearance, diagnostic horizons are based on soil formation processes. There are two types of diagnostic horizons. These are surface (epipedon) and subsurface horizon (Endopedon).

EPIPEDONS

An epipedon is the surface, or uppermost soil horizon. They are not synonymous to the A horizon. They may be thinner than the A horizon, or include the E or part or the entire B horizon.

Histic epipedon

This organic horizon is water saturated long enough for reduced conditions to occur unless artificially drained. It is 40 to 60 cm thick and has a low bulk density often less than 1 g cm^3.

Mollic epipedon

This epipedon is a soft dark grassland soil. Its organic carbon content is 0.6 percent or more; its base saturation is 50 percent or more; It has a minimum thickness of 18 cmand contains less than 250 ppm P_2O_5.

Anthropic epipedon

While similar to the mollic epipedon, the anthropic epipedon contains greater than 250 ppm citric acid soluble P_2O_5 with or without a 50 percent base saturation.

Umbric epipedon

Mollic-like in thickness, organic carbon content, color, P_2O_5 content, consistence, and structure, this epipedon has less than 50 percent base saturation.

Ochric epipedon

Ochric epipedon is light in colour and low in organic matter and too thin to be any of the other five epipedons. Ochric epipedon is the most common epipedon in Nigerian soils.

Plaggen epipedon

This man-made horizon is 50 cm or more thick and has resulted from centuries of accumulation of sod, straw, and manure, for example. It commonly contains artifacts such as pottery and bricks.

DIAGNOSTIC SUBSURFACE HORIZONS

Diagnostic subsurface horizons can be categorized as weakly developed horizons, as horizons featuring an accumulation of clay, organic matter, or inorganic salts, as cemented horizons, or as strongly acidic horizons.

Agric

The agric horizon is an illuvial horizon that has formed under cultivation and contains significant amounts of illuvial silt, clay, and humus. It is usually formed after prolonged years of cultivation.

Albic

Albic (L. *albus*, white) materials are soil materials with a color that is largely determined by the color of primary sand and silt particles rather than by the color of their coatings.

Argillic (Bt)

An argillic horizon is normally a subsurface horizon with a significantly higher percentage of phyllosilicate clay than the overlying soil material. It shows evidence of clay illuviation.

Calcic

The calcic horizon is an illuvial horizon in which secondary calcium carbonate or other carbonates have accumulated to a significant extent.

Cambic

This horizon shows some evidence of alterations but is very weakly developed between A and C horizons. The cambic horizon has less illuviation evidence than found in the argillic and spodic horizons.

Gypsic (By) accumulation of $CaSO_4$; 15 cm or more thick 5% or more calcium sulfate.

Glossic (B/E) consists of an eluvial part (E - albic) and an illuvial part (Bt - argillic, or Bto- kandic or Btn-natric) sometimes referred to as tounging

Kandic (Bto) - fine textured subsurface horizon that has evidence of clay translocation and is composed mostly of low activity clays (low CEC and ECEC). The CEC (by the 1N NH_4OAC method at pH=7) is 16 cmol(+) or less per kg of clay and the ECEC (by the basic cations displaced by ammonium plus KCl extractable aluminum methods) is 12 cmol(+) or less per kg of clay.

Natric (Btn) - meets all the requirements of the argillic horizon and, in addition, has: a. either prismatic or columnar structure b. either (1) an exchangeable sodium percentage of 15 percent or more or (2) a sodium adsorption ratio (SAR) of 13 or more.

Oxic (Bo) - highly weathered horizon that consists of oxides of iron and aluminum, 1:1 clays and resistant minerals such as quartz. It has a thickness of 30 cm or more; less than 10 percent weatherable minerals; low CEC (≤ 16 cmol(+) per kg of clay

Salic (Bz) soluble salt accumulation - salts more soluble than gypsum 15 cm or more thick EC _>_ 30dS/m in a 1:1 soil water extract

Spodic (Bs or Bhs) - illuvial accumulations of sesquioxides and/or organic matter composed of spodic materials.

Other Diagnostic Soil Features

Abrupt textural change. Ochric or Albic overlies an argillic considerable increase in clay over a short distance in the profile usually double the clay content within a vertical distance of 7.5 cm

Glacic - (Bf). Ice in the form of ice lenses or wedges.

Lamellae - (Bt or Bw). Number of clay-enriched layers separated by coarser textured layers illuvial horizon less than 7.5 cm thick horizontal bands contain an accumulation of oriented clay bridging sand grains lamellae occur in a vertical series of two or more; each lamellae has an overlying eluvial.

Lithologic discontinuity. (Numerical prefix; e.g. 2Bt1) change in parent material geologic process rather than pedogenic possibly indicated by abrupt textural change, contrasting particle sizes, stone lines, mineral composition or orientation of rocks.

Plinthite - (Bv). Humus poor, iron-rich, ironstone hardpan hardens irreversibly after being exposed to repeated wetting and drying in place begins as soft, red iron segregations (mottled appearance) due to oxidation.

Slickensides - (Bss). Polished or grooved clay surfaces produced by one soil mass sliding against another common in shrink-swell clays indicates vertic.

Densic contact - (Bd or Cd). Boundary between soil and underlying densic material (plow pan, glacial till, etc).

Lithic contact - (R). Boundary between soil and consolidated underlying material digging with hand tools is impractical.

Paralithic contact - (Cr). Boundary between soil and weathered bedrock underlying material can be dug with hand tools.

CLIMATOLOGICAL DATA: A Source of criteria for soil classification.

Soil Moisture Regimes

The term "soil moisture regime" refers to the presence or absence either of ground water or of water held at a tension of less than 1500 kPa in the soil or in specific horizons during periods of the year.

Classes of Soil Moisture Regimes

Aquic moisture regime. The aquic moisture regime is a reducing regime in a soil that is virtually free of dissolved oxygen because it is saturated by water.

Aridic and torric moisture regimes. These terms are used for the same moisture regime but in different categories of the taxonomy. In the aridic (torric) moisture regime, the moisture control section is dry in all parts for more than half of the cumulative days per year.

Udic moisture regime. The udic moisture regime is one in which the soil moisture control section is not dry in any part for as long as 90 cumulative days in normal years.

Ustic moisture regime. The ustic moisture regime is intermediate between the aridic regime and the udic regime. Its concept is one of moisture that is limited but is present at a time when conditions are suitable for plant growth.

Xeric moisture regime. The xeric moisture regime is the typical moisture regime in areas of Mediterranean climates, where winters are moist and cool and summers are warm and dry.

SOIL TEMPERATURE REGIMES

Classes of Soil Temperature Regimes

Following is a description of the soil temperature regimes used in defining classes at various categoric levels in this taxonomy.

Cryic (Gr. *kryos*, coldness; meaning very cold soils). Soils in this temperature regime have a mean annual temperature lower than 8 ^{oC} but do not have permafrost.

Frigid. A soil with a frigid temperature regime is warmer in summer than a soil with a cryic regime, but its mean annual temperature is lower than 8 ^{oC} and the difference between mean summer and mean winter soil temperatures is more than 6 ^{oC}

Mesic. The mean annual soil temperature is 8 ^{oC} or higher but lower than 15 ^{oC}, and the difference between mean summer and mean winter soil temperatures is more than 6 ^{oC}.

Thermic. The mean annual soil temperature is 15 ^{oC} or higher but lower than 22 ^{oC}, and the difference between mean summer and mean winter soil temperatures is more than 6 ^{oC}.

Hyperthermic. The mean annual soil temperature is 22 ^{oC} or higher, and the difference between mean summer and mean winter soil temperatures is more than 6 ^{oC}.

ISO

If the name of a soil temperature regime has the prefix *iso*, the mean summer and mean winter soil temperatures differ by less than 6 ^{oC}.

SOIL CLASSIFICATION

International Soil Classification Systems

There are two major world soil classification systems. These are the United State Department of Agriculture (UDSA) taxonomic system and the World Food and Agricultural Organization (FAO) World Reference Base System (USDA, 2003; FAO, 2006). These are systems designed for universal application. They should classify any soil, and serve to **correlate** experiences on similar soils all over the world.

USDA SYSTEM OF SOIL CLASSIFICATION

The USDA classification system is a multi- categorical and hierarchical system. Thus the classes in the highest categories are divided into smaller classes in the lower one and continue to the lowest level, which is the soil series.

The USDA system comprise a hierarchy of 6 levels

- Orders (12) (surface and subsurface diagnostic horizons)
- Suborders (55) (Soil temperature. and moisture regimes)
- Great group (238) (subsurface diagnostic horizon)
- Subgroup (1243) (drainage, lithic contact, PM, clay type)
- Family (7504) (Texture of diagnostic surface horizon)
- Series (about 19,000) in U.S.

12 orders:

Alfisols

Andisols (*ando* – blacksoil)

Aridisols (*aridus* – dry)

Entisols (rec*ent*)

Gelisols (*gelid* – very cold)

Histosols (*histos* – tissue)

Inceptisols (*inceptum* – beginning)

Mollisols (*mollis* – soft)

Oxisols (*oxide*)

Spodosols (*spodos* – wood ash)

Ultisols (*ultimus* – last)

Vertisols (*verto* – turn)

FAO/UNESCO CLASSIFICATION SYSTEM

The FAO/UNESCO system was developed by a panel set up by UNESCO for providing the basic unit for the soil map of the world. This classification was compiled from diverse systems in term of category and nomenclature. The FAO system has two categories, a higher and a lower one. These categories have not been given name. From their definition, the higher category is equivalent to the great group of the USDA taxonomy while the lower category cannot be fitted into any category of the USDA.

The criteria for classification are similar to those of great group and sub group in the USDA taxonomy. The definition of diagnostic horizons in the FAO system is different from that of the USDA system, although there are many equivalent definitions. For example, argillic horizon in the USDA is the same as argic horizon in the FAO, while Albic, calcic, cambic, duric, histic, melanic, gypsic and nitric horizons has definition similar to those horizons bearing the same nomenclature in the USDA system.

There are 32 reference groups in the FAO (WRB, 2006) system:- Acrisols, Albeluvisols, Alisols, Andosols, Anthrosols, Arenosols, Calcisols, Cambisols, Chernozems, Cryosols, Durisols, Ferralsols, Fluvisols, Gleysols, Cypsisols, Histosols, Kastanozems, Leptosols, Lixisols, Luvisols, Nitosols, Phaeozems, Planosols, Plinthosols, Podzols, Regosols, Solonckak, Solonetz, Stagnosols, Technosols, Umbrisols and Vertisols.

Common group in Nigeria soils are Plinthosols, Ferralsols, Stagnosols (mangrove soils), Alisols (ultisols), Acrisols (ultisols), Luvisols, Lixisols (alfisols), Arenosols, Cambisols and Regosols.

The names of soils are indicated by adding prefix and suffix adjectives from the qualifier lists to the reference group, for example Gleyic Luvisol oxyaquic.

Local soil classification Systems

A number of soil classification systems exist within the country that is native of the country. These includes:-

- Smith and Montgomery (1962)
- Moss (1957)
- Jungerius (1964)
- Klinkenberg and Higgins (1968)

***SOIL* SURVEY**

Soil survey is a branch of soil science which involves the identification of the different types of soil in a given landscape and the location of their distribution to scale on a map. In addition, soil survey provides information on the quality of the land in terms of their response to management and manipulation.

Mapping Unit

A mapping unit is a geographical unit and it is an area of land within which the greater proportion is occupied by the taxonomic class after which it is named.

Principles of soil survey

The principles of survey can be discussed under five points

- A soil survey must have an objective.
- A soil survey is not the only basis for decision on land use and management, it is only an aid
- Land resources do not consist of soils alone

- A soil map must show soils.
- Soil map and report are complementary..

Type of Survey

Soil survey can be classified using the following criteria

Purpose of survey

Regularity of observation

Based on scale of mapping

Classification by purpose of survey

Based on the purpose of survey, there are two types of survey. These are general purpose and special purpose survey.

A general purpose soil survey is one that is done mainly to add to the already existing inventory of soil information.

A special purpose soil survey is done for specific purpose in mind, e.g. survey for irrigation or survey for citrus plantation.

Based on regularity of observation, three kinds of surveys have been distinguished: - free survey, rigid grid and flexible grid.

In **free survey**, there is no rigid pattern of observation.

In **rigid grid survey**, examinations of the soil are done at regular and pre-determined interval. **Flexible grid survey method** is a compromise between the free and rigid grid methods of survey. In this system of survey, the number of observation is fixed but the location of the observation points are not pre-determined and can be fixed at will.

Based on the scale of mapping, there are seven kinds of surveys:- compilation, integrated survey, exploratory survey, reconnaissance survey, semi-detailed survey, detailed survey and intensive survey.

Compilation: These are soil maps produced by abstraction from other soil surveys. And where they exist they are filled by inferences. The scale is usually at 1: 100,000 or smaller.

Integrated survey: This is also known as land system survey. It is based on mapping the total physical environment and the scale is 1: 250,000 or smaller.

Exploratory survey: They are usually rapid road traverse made to provide modicum of information about the area that are otherwise unknown. Scale of exploratory survey varies from 1: 2,000,000 to 1,500,000.

Reconnaissance survey: They are the smallest scale of survey where the whole area is still covered using remote sensed imageries and the scale is usually 1:250,000

Semi-Detailed survey: In a semi-detailed mapping units are usually soil association and the scale of mapping varies from 150,000 to 100, 000.

Detailed survey: Detailed surveys are executed using rigid grid method and are usually employed for small area. Scale of observation varies between 1: 10,000 and 1: 25,000. Mapping unit are usually soil series.

Intensive survey uses rigid grid approach and mapping units are soil series and phase of soil series. Scale of mapping varies from 1: 1,000 to 1: 10,000.