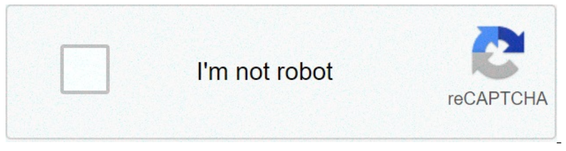

Continue

Labelled diagram of soil profile

Question 1 What is meant by soil profile?Draw a sketch of the soil profile and label the various layers? Question 2 What is soil? How is soil formed? Question 3 Define the term humus? Question 4 State few important uses of soil? Question 5 What is meant by weathering? Question 6 Name the various types of rock particles present in soil? Soil The uppermost layer of earth's crust (in which plants grow) is called soil. Humus Soil is a dark brown (or black) solid material which is a mixture of rock particles of various sizes and decayed plant and animal matter called humus. Soil also contains air, water and countless living organisms. Soil is essential for the existence of life on the earth. Soil supports the growth of plants (and trees) by holding their roots firmly and by supplying them with water and nutrients. Important uses of soil (1) Soil is used for growing food (like grains, pulses, fruits and vegetables, etc.). (2) Soil is used to grow trees for obtaining wood for building purposes (timber), for burning as fuel (firewood) and for making paper. (3) Soil is used to grow cotton plants which give us cotton clothes. Soil is also used to grow mulberry trees for rearing silkworms which provide us silk for making silk clothes. (4) Soil is used to make bricks and mortar for building houses. (5) Soil is used to make earthenware or pottery (such as matkas, surahis, etc.), crockery (cups and plates), toys and statues, etc. The process by which huge rocks are broken down into small particles by the action of sun's heat, wind, rain and flowing river water, etc, is called weathering. The organic matter formed by the decomposition of dead plants and animals by the micro-organisms (like certain bacteria and fungi) is called humus. Humus contains nutrients (like nitrogen and phosphorus, etc,) which are needed by the plants for their growth. Formation of soil Soil is formed from rocks by the process of weathering. In weathering, rocks are broken down very slowly by the action of sun's heat, wind, rain, flowing river water, etc, to form tiny rock particles. These tiny rock particles then mix up with humus to form fertile soil. The nature of any soil depends on the rocks from which it has been formed and the type of vegetation that grows in it. Soil Profile A vertical section (or cutting) through the soil showing the different layers of soil is called soil profile. Soil profile consists of three different layers of soil. Horizon Each layer of soil is called a horizon. The three lavers of soil in the soil profile are: 1) A-horizon (or Top-soil) 2)B-horizon (or Sub-soil) 3)C-horizon (or Sub-stratum) A-Horizon (or Top-Soil) The top layer of soil is called A-horizon. Top soil is dark in colour. This is because top-soil is rich in minerals and humus. The plant roots grow in the top-soil. The top-soil contains many living things. Top-soil contains a lot of decayed dead plants and animal remains. In other words, top-soil contains a lot of humus. This humus makes the top-soil very fertile. The top-soil is soft and porous, and can hold more of water. The top-soil is rich in minerals which the plants need for growth. Top-soil is the most useful part of the soil. B-Horizon (or Sub-Soil) The layer of soil which is just below the top-soil is called B-horizon. It is also known as sub-soil. The sub-soil is made up of slightly bigger rock particles than that of top-soil. It is somewhat harder and more compact than the top-soil. Sub-soil is also lighter in colour than the top-soil. The sub-soil contains very little living organisms. The roots of some of the trees are, however, able to reach sub-soil. The sub-soil has very little humus (decayed organic matter). Due to this, sub-soil is much less fertile as compared to the top-soil. Sub-soil is rich in soluble minerals. C-Horizon (or Sub-Stratum) The layer of soil which is just below the sub-soil is called C-horizon. It is also called sub-stratum. Sub-stratum is made up of small lumps of broken rocks (or stones) formed by the partial weathering of bed-rock (or parent rock). Below the C-horizon we have unweathered solid rock called bed-rock (or parent rock).It is this bed-rock (or parent rock) which has produced the soil over a long period of time. The soil is made up of six components: Rock particles (of different sizes), Minerals, Humus (Organic matter), Air, Water and Living organisms. The rock particles present in soil are of different sizes and chemical compositions. On the basis of their sizes, the rock particles present in soil can be divided mainly into four groups: Clay, Silt, Sand and Gravel. 1) The smallest rock particles present in soil form clay.Because of its very small particles, clay feels smooth to touch. (2) The rock particles in soil which are a little larger than clay particles form silt. Thus, silt is made up of rock particles somewhat bigger than that of clay. Due to its slightly bigger sized particles, silt is not so smooth. Actually, the size of silt particles is in-between that of clay and sand. The size of silt particles is bigger than that of clay particles but smaller than those of sand particles. Silt occurs as a deposit in river beds. (3) The rock particles in soil which are larger than silt particles form sand. Being quite large, sand particles can be easily seen by us. And because of its large sized particles, sand is coarse to touch. (4) The largest sized rock particles present in soil are called gravel. Gravel is a kind of tiny stones.The amount of gravel present in a good top-soil is very small. In a good top-soil, gravel is present in very small amount.The main rock particles present in the top-soil are sand, clay and silt. So, depending on its composition, a soil can be classified as sandy soil, clayey soil or loamy soil. All these soils have different proportions of rock particles of different sizes. The sizes of rock particles in a soil have a very important influence on the properties of that soil. This section provides information on the different types of soil and soil profiles. You will become familiar with different soil types, their components and common locations. What You'll Learn to Do Identify the measurable components of soil: sand, silt, and clay. Identify the primary soil horizons: organic, topsoil, subsoils, and C horizon. Identify three common (and important!) types of soil: pedalfer, pedocal, and laterite. Figure 1. A loam field. The inorganic portion of soil is made of many different size particles, and these different size particles are present in different proportions. The combination of these two factors determines some of the properties of the soil. A permeable soil allows water to flow through it easily because the spaces between the inorganic particles are large and well connected. Sandy or silty soils are considered 'light' soils because they are permeable, water-draining types of soils. Soils that have lots of very small spaces are water-holding soils. For example, when clay is present in a soil, the soil is heavier, holds together more tightly, and holds water. When a soil contains a mixture of grain sizes, the soil is called a loam (figure 1). When soil scientists want to precisely determine soil type, they measure the percentage of sand, silt, and clay. They plot this information on a triangular diagram, with each size particle at one corner (figure 2). The soil type can then be determined from the location on the diagram. At the top, a soil would be clay; at the left corner, it would be sand, and at the right corner it would be silt. Soils in the lower middle with less than 50% clay are loams. Figure 2. Soil types by particle size. Using the chart as a guide, what is the composition of a sandy clay loam? If you would like to determine soil type by feel, here's a chart from the USDA to help you. Soil Horizons and Profiles A residual soil forms over many years, as mechanical and chemical weathering slowly change solid rock into soil. The development of a residual soil may go something like this. Figure 3. Soil is an important resource. Each soil horizon is distinctly visible in this photograph. The bedrock fractures because of weathering from ice wedging or another physical process. Water, oxygen, and carbon dioxide seep into the cracks to cause chemical weathering. Plants, such as lichens or grasses, become established and produce biological weathering. Weathered material collects until there is soil. The soil develops soil horizons, as each layer becomes progressively altered. The greatest degree of weathering is in the top layer. Each successive, lower layer is altered just a little bit less. This is because the first place where water and air come in contact with the soil is at the top. A cut in the side of a hillside shows each of the different layers of soil. All together, these are called a soil profile (figure 3). The simplest soils have three horizons: topsoil (A horizon), subsoil (B horizon), and C horizon. Topsoil Figure 4. A soil profile is the complete set of soil layers. Each layer is called a horizon. Called the A horizon, the topsoil is usually the darkest layer of the soil because it has the highest proportion of organic material. The topsoil is the region of most intense biological activity: insects, worms, and other animals burrow through it and plants stretch their roots down into it. Plant roots help to hold this layer of soil in place. In the topsoil, minerals may dissolve in the fresh water that moves through it to be carried to lower layers of the soil. Very small particles, such as clay, may also get carried to lower layers as water seeps down into the ground. Subsoil The B horizon or subsoil is where soluble minerals and clays accumulate. This layer is lighter brown and holds more water than the topsoil because of the presence of iron and clay minerals. There is less organic material. Look at figure 4. C horizon The C horizon is a layer of partially altered bedrock. There is some evidence of weathering in this layer, but pieces of the original rock are seen and can be identified. Not all climate regions develop soils, and not all regions develop the same horizons. Some areas develop as many as five or six distinct layers, while others develop only very thin soils or perhaps no soils at all. Types of Soils Although soil scientists recognize thousands of types of soil—each with its own specific characteristics and name—let's consider just three soil types. This will help you to understand some of the basic ideas about how climate produces a certain type of soil, but there are many exceptions to what we will learn right now (figure 5). Figure 5. Just some of the thousands of soil types. Pedalfer Figure 6. A pedalfer is the dark, fertile type of soil that will form in a forested region. Deciduous trees, the trees that lose their leaves each winter, need at least 65 cm of rain per year. These forests produce soils called pedalfers, which are common in many areas of the temperate, eastern part of the United States (figure 6). The word pedalfer comes from some of the elements that are commonly found in the soil. The Al in pedalfer is the chemical symbol of the element aluminum, and the Fe in pedalfer is the chemical symbol for iron. Pedalfers are usually a very fertile, dark brown or black soil. Not surprising, they are rich in aluminum clays and iron oxides. Because a great deal of rainfall is common in this climate, most of the soluble minerals dissolve and are carried away, leaving the less soluble clays and iron oxides behind. Pedocal Figure 7. A pedocal is the alkaline type of soil that forms in grassland regions. Pedocal soils form in drier, temperate areas where grasslands and brush are the usual types of vegetation (figure 7). The climates that form pedocals have less than 65 cm rainfall per year, so compared to pedalfers, there is less chemical weathering and less water to dissolve away soluble minerals so more soluble minerals are present and fewer clay minerals are produced. It is a drier region with less vegetation, so the soils have lower amounts of organic material and are less fertile. A pedocal is named for the calcite enriched layer that forms. Water begins to move down through the soil layers, but before it gets very far, it begins to evaporate. Soluble minerals, like calcium carbonate, concentrate in a layer that marks the lowest place that water was able to reach. This layer is called caliche. Laterite Figure 8. A laterite is the type of thick, nutrient poor soil that forms in the rainforest. In tropical rainforests where it rains literally every day, laterite soils form (figure 8). In these hot, wet, tropical regions, intense chemical weathering strips the soils of their nutrients. There is practically no humus. All soluble minerals are removed from the soil and all plant nutrients are carried away. All that is left behind are the least soluble materials, like aluminum and iron oxides. These soils are often red in color from the iron oxides. Laterite soils bake as hard as a brick if they are exposed to the sun. Many climates types have not been mentioned here. Each produces a distinctive soil type that forms in the particular circumstances found there. Where there is less weathering, soils are thinner but soluble minerals may be present. Where there is intense weathering, soils may be thick but nutrient poor. Soil development takes a very long time, it may take hundreds or even thousands of years for a good fertile topsoil to form. Soil scientists estimate that in the very best soil-forming conditions, soil forms at a rate of about 1mm/year. In poor conditions, soil formation may take thousands of years! Check Your Understanding Answer the question(s) below to see how well you understand the topics covered in the previous section. This short quiz does not count toward your grade in the class, and you can retake it an unlimited number of times. Use this quiz to check your understanding and decide whether to (1) study the previous section further or (2) move on to the next section. Soil layer whose physical characteristics differ from the layers above and beneath A cross section of a soil, revealing horizons A soil horizon is a layer parallel to the soil surface whose physical, chemical and biological characteristics differ from the layers above and beneath. Horizons are defined in many cases by obvious physical features, mainly colour and texture. These may be described both in absolute terms (particle size distribution for texture, for instance) and in terms relative to the surrounding material, i.e. 'coarser' or 'sandier' than the horizons above and below. The identified horizons are indicated with symbols, which are mostly used in a hierarchical way. Master horizons (main horizons) are indicated by capital letters. Suffixes, in form of lowercase letters and figures, further differentiate the master horizons. There are many different systems of horizon symbols in the world. No one system is more correct – as artificial constructs, their utility lies in their ability to accurately describe local conditions in a consistent manner. Due to the different definitions of the horizon symbols, the systems cannot be mixed. In most soil classification systems, horizons are used to define soil types. The German system uses entire horizon sequences for definition.[1] Other systems pick out certain horizons, the "diagnostic horizons", for the definition; examples are the World Reference Base for Soil Resources (WRB),[2] the USDA soil taxonomy[3] and the Australian Soil Classification.[4] Diagnostic horizons are usually indicated with names, e.g. the "cambic horizon" or the "spodic horizon". The WRB lists 37 diagnostic horizons. In addition to these diagnostic horizons, some other soil characteristics may be needed to define a soil type. Some soils do not have a clear development of horizons. A soil horizon is a result of soil-forming processes (pedogenesis).[5] Layers that have not undergone such processes may be simply called "layers". Horizon sequence Many soils have an organic surface layer, which is denominated with a capital letter (different letters, depending from the system). The mineral soil usually starts with an A horizon. If a well-developed subsoil horizon as a result of soil formation exists, it is generally called a B horizon. An underlying loose, but poorly developed horizon is called a C horizon. Hard bedrock is mostly denominated R. Most individual systems defined more horizons and layers than just these five. In the following, the horizons and layers are listed more or less by their position from top to bottom within the soil profile. Not all of them are present in every soil. Soils with a history of human interference, for instance through major earthworks or regular deep ploughing, may lack distinct horizons almost completely. When examining soils in the field, attention must be paid to the local geomorphology and the historical uses, to which the land has been put, in order to ensure that the appropriate names are applied to the observed horizons. Example of a soil profile O) Organic surface layer: Plant litter layer, the upper part often relatively undecomposed, but the lower part may be strongly humified. A) Surface soil: Layer of mineral soil with most organic matter accumulation and soil life. Additionally, due to weathering, oxides (mainly iron oxides) and clay minerals are formed and accumulated. It has a pronounced soil structure. But in some soils, clay minerals, iron, aluminum, organic compounds, and other constituents are soluble and move downwards. When this eluviation is pronounced, a lighter coloured E subsurface soil horizon is apparent at the base of the A horizon. The A horizon may also be the result of a combination of soil bioturbation and surface processes that winnow fine particles from biologically mounded topsoil. In this case, the A horizon is regarded as a "biomantle". B) Subsoil: This layer normally has less organic matter than the A horizon, so its colour is mainly derived from iron oxides. Iron oxides and clay minerals accumulate as a result of weathering. In soil, where substances move down from the topsoil, this is the layer where they accumulate. The process of accumulation of clay minerals, iron, aluminum, and organic compounds, is referred to as illuviation. The B horizon has generally a soil structure. C) Substratum: Layer of non-indurated poorly weathered or unweathered rocks. This layer may accumulate more soluble compounds like CaCO3. Soils formed in situ from non-indurated material exhibit similarities to this C layer. R) Bedrock: R horizons denote the layer of partially weathered or unweathered bedrock at the base of the soil profile. Unlike the above layers, R horizons largely comprise continuous masses (as opposed to boulders) of hard rock that cannot be excavated by hand. Soils formed in situ from bedrock will exhibit strong similarities to this bedrock layer. Horizons according to the Australian Soil and Land Survey Field Handbook (2009) Source:[6] Horizons O horizon Main article: Organic matter The "O" stands for organic matter. It is a surface layer, dominated by the presence of large amounts of organic matter in varying stages of decomposition. In the Australian system, the O horizon should be considered distinct from the layer of leaf litter covering many heavily vegetated areas, which contains no weathered mineral particles and is not part of the soil itself. O horizons may be divided into O1 and O2 categories, whereby O1 horizons contain undecomposed matter whose origin can be spotted on sight (for instance, fragments of leaves), and O2 horizons contain organic debris in various stages of decomposition, the origin of which is not readily visible. O horizons contain ≥ 20% organic carbon. P horizon Main article: Humus See also: Peat These horizons are also heavily organic, but are distinct from O horizons in that they form under waterlogged conditions. The "P" designation comes from their common name, peats. They may be divided into P1 and P2 in the same way as O horizons. P horizons contain ≥ 12 to 18% organic carbon, depending on the clay content. A horizon Main article: topsoil Surface runoff, a potential pathway for nonpoint source pollution, from a farm field in Iowa during a rain storm. The A horizon is the top layer of the mineral soil horizons, often referred to as 'topsoil'. This layer contains dark decomposed organic matter, which is called "humus". The technical definition of an A horizon may vary between the systems, but it is most commonly described in terms relative to deeper layers. "A" horizons may be darker in colour than deeper layers and contain more organic matter, or they may be lighter but contain less clay or pedogenic oxides. The A is a surface horizon, and as such is also known as the zone in which most biological activity occurs. Soil organisms such as earthworms, potworms (enchytraeids), arthropods, nematodes, fungi, and many species of bacteria and archaea are concentrated here, often in close association with plant roots. Thus, the A horizon may be referred to as the biomantle.[7][8] However, since biological activity extends far deeper into the soil, it cannot be used as a chief distinguishing feature of an A horizon. The A horizon may be further subdivided into A1 (dark, maximum biologic activity), A2 (paler) and A3 (transitional to the B horizon). E horizon (not used in the Australian system) Main article: Eluvium Albic Luvisol – dark surface horizon on a bleached subsurface horizon that tongues into a clay illuviation (Bt) horizon "E", being short for eluviated, is most commonly used to label a horizon that has been significantly leached of its mineral and/or organic content, leaving a pale layer largely composed of silicates or silica. These are present only in older, well-developed soils, and generally occur between the A and B horizons. In systems where (like in the Australian system) this designation is not employed, leached layers are classified firstly as an A or B according to other characteristics, and then appended with the designation "e" (see the section below on horizon suffixes). In soils that contain gravels, due to animal bioturbation, a stonelayer commonly forms near or at the base of the E horizon. B horizon Main article: Subsoil The B horizon is commonly referred to as "subsoil" and consists of mineral layers which are significantly altered by pedogenesis, mostly with the formation of iron oxides and clay minerals. It is usually brownish or reddish due to the iron oxides, which increases the chroma of the subsoil to a degree that it can be distinguished from the other horizons. The weathering may be biologically mediated. In addition, the B horizon is defined as having a distinctly different structure or consistency than the horizon(s) above and the horizon(s) below. The B horizon can also accumulate minerals and organic matter that are migrating downwards from the A and E horizons. If so, this layer is also known as the illuviated or illuvial horizon. As with the A horizon, the B horizon may be divided into B1, B2, and B3 types under the Australian system. B1 is a transitional horizon of the opposite nature to an A3 – dominated by the properties of the B horizons below it, but containing some A-horizon characteristics. B2 horizons have a high concentration of clay minerals or oxides. B3 horizons are transitional between the overlying B layers and the material beneath it, whether C or D horizon. The A3, B1, and B3 horizons are not tightly defined, and their use is generally at the discretion of the individual worker. Plant roots penetrate throughout this layer, but it has very little humus. The A/E/B horizons are referred to collectively as the "solum", the surface depth of the soil where biologically activity and climate effects drives pedogenesis. The layers below the solum have no collective name but are distinct in that they are noticeably less affected by surface soil-forming processes. C horizon Main article: Parent material The C horizon is below the solum horizons. This layer is little affected by pedogenesis. Clay illuviation, if present, is not significant. The absence of solum-type development (pedogenesis) is one of the defining attributes. The C horizon forms either in deposits (e.g., loess, flood deposits, landslides) or it formed from weathering of residual bedrock. The C horizon may be enriched with carbonates carried below the solum by leaching. If there is no lithologic discontinuity between the solum and the C horizon and no underlying bedrock present, the C horizon resembles the parent material of the solum. Soil with broken rock fragments overlying bedrock, Sandside Bay, Caithness D horizon D horizons are not universally distinguished, but in the Australian system refer to "any soil material below the solum that is unlike the solum in its general character, is not C horizon, and cannot be given reliable horizon designation... [it] may be recognized by the contrast in pedologic organization between it and the overlying horizons" (National Committee on Soil and Terrain, 2009, p. 151). R horizon Main article: bedrock R horizons denote the layer of partially weathered or unweathered bedrock at the base of the soil profile. Unlike the above layers, R horizons largely comprise continuous masses (as opposed to boulders) of hard rock that cannot be excavated by hand. If there is no lithologic discontinuity between the solum and the R horizon, the R horizon resembles the parent material of the solum. L horizon (not used in the Australian system) Main article: Limnic L (Limnic) horizons or layers indicate mineral or organic material that has been deposited in water by precipitation or through the actions of aquatic organisms. Included are coprogenous earth (sedimentary peat), diatomaceous earth, and marl; and is usually found as a remnant of past bodies of standing water. Transitional horizons A horizon that combines the characteristics of two horizons is indicated with both capital letters, the dominant one written first. Example: AB and BA. If distinct parts have properties of two kinds of horizons, the horizon symbols are combined using a slash (/). Example: A/B and B/A. Horizon suffixes In addition to the main descriptors above, several modifiers exist to add necessary detail to each horizon. Firstly, each major horizon may be divided into sub-horizons by the addition of a numerical subscript, based on minor shifts in colour or texture with increasing depth (e.g., B21, B22, B23 etc.). While this can add necessary depth to a field description, workers should bear in mind that excessive division of a soil profile into narrow sub-horizons should be avoided. Walking as little as ten metres in any direction and digging another hole can often reveal a very different profile in regards to the depth and thickness of each horizon. Over-precise description can be a waste of time. In the Australian system, as a rule of thumb, layers thinner than 5 cm (2 inches) or so are best described as pans or segregations within a horizon rather than as a distinct layer. Suffixes describing particular features of a horizon may also be added. The Australian system provides the following suffixes: b: buried horizon. c: presence of mineral concretions or nodules, perhaps of iron, aluminium, or manganese. d: root restricting layer. e: conspicuously bleached. f: faunal accumulations in A horizons. g: gleyed horizon. h: accumulation of organic matter. j: sporadically bleached. k: accumulation of carbonates, commonly calcium carbonate. m: strong cementation or induration. p: disturbed by ploughing or other tillage practices (A horizons only). q: accumulation of secondary silica. r: weathered, digable rock. s: sesquioxide accumulation. t: accumulation of clay minerals. w: weak development. x: fragipan. y: accumulation of calcium sulfate (gypsum). z: accumulation of salts more soluble than calcium sulfate. Buried soils Main article: Paleosol Soil formation is often described as occurring in situ: Rock breaks down, weathers and is mixed with other materials, or loose sediments are transformed by weathering. But the process is often far more complicated. For instance, a fully formed profile may have developed in an area only to be buried by wind- or water-deposited sediments which later formed into another soil profile. This sort of occurrence is most common in coastal areas, and descriptions are modified by numerical prefixes. Thus, a profile containing a buried sequence could be structured O, A1, A2, B2, 2A2, 2B21, 2B22, 2C with the buried profile commencing at 2A2. Horizons and layers according to the USDA Field Book for Describing and Sampling Soils Source:[9] Master horizons and layers O: Organic soil materials (not limnic). A: Mineral; organic matter (humus) accumulation. E: Mineral; some loss of Fe, Al, clay, or organic matter. B: Subsurface accumulation of clay, Fe, Al, Si, humus, CaCO3, CaSO4; or loss of CaCO3; or accumulation of sesquioxides; or subsurface soil structure. C: Little or no pedogenic alteration, unconsolidated earthy material, soft bedrock. L: Limnic soil materials. W: A layer of liquid water (W) or permanently frozen water (Wf) within or beneath the soil (excludes water/ice above soil). M: Root-limiting subsoil layers of human-manufactured materials. R: Bedrock, strongly cemented to indurated. Transitional horizons and layers A horizon that combines the characteristics of two master horizons is indicated with both capital letters, the dominant one written first. Example: AB and BA. If discrete, intermingled bodies of two master horizons occur together, the horizon symbols are combined using a slash (/). Example: A/B and B/A. Horizon suffixes a: Highly decomposed organic matter (used only with O). aa: (proposed) Accumulation of anhydrite (CaSO4). b: Buried genetic horizon (not used with C horizons). c: Concretions or nodules. co: Coprogenous earth (used only with L). d: Densic layer (physically root restrictive). di: Diatomaceous earth (used only with L). e: Moderately decomposed organic matter (used only with O). f: Permanently frozen soil or ice (permafrost); continuous subsurface ice; not seasonal ice. ff: Permanently frozen soil ("dry" permafrost); no continuous ice; not seasonal ice. g: Strong gley. h: Illuvial organic matter accumulation. i: Slightly decomposed organic matter (used only with O). j: Jarosite accumulation. jj: Evidence of cryoturbation. k: Pedogenic CaCO3 accumulation (