CLASS COPY – DO NOT KEEP OR WRITE ON!

Soil

Instructions:

On a separate sheet of paper, put your Name, Period, the Date, and the title of this article. As you read the *Soil* article, answer the items below in your own words. **You must write the question & answer!**

General Introduction

1. What is meant by the statement, "Perhaps no other single natural resource is as influential as soils."? (*Why is soil so important?)*

What is Soil?

2. Define soil.
3. What are the main components, with their percentage by volume, of soil?
4. How soil is formed?
5. How is soil important in the hydrologic, carbon, and nutrient cycles?
6. What are the 5 main functions of soil *(list & describe each)*

Soil Horizons

7. What are the soil horizons? *(list & describe each)*

Soil Color

8. Why is soil color important?

Soil Texture

9. Why is texture considered the single most important soil characteristic?
10. Why are the three separates found in soil? What size are they? (*list & describe each)*

Soil

Perhaps no other single natural resource is as influential as soils. It affects our daily lives in ways we may not be aware of: food and fiber, the beauty of a forest or a lake, clean drinking water and filtration of chemical pollutants are all tied to the soil resource. Functions of soil include plant growth (food and fiber, as well as aesthetics), providing physical support for our infrastructure (roads and buildings), and purification and filtration of water. The soil serves as a reservoir for wastes either through purification or by storage, and it provides materials such as clays or silica sands that are necessary for industrial processes.

What is Soil?

Soil covers much of the Earth's land surface area, and it is comprised of minerals (rock, sand, silt, clay), air, water, and organic matter (living organisms and the remains of plants and animals).

In a very basic sense, soil can be defined as unconsolidated mineral and organic matter on the Earth's surface that can be used as a medium for plant growth. A more complicated and comprehensive definition of soil is as follows: The unconsolidated mineral and organic matter on the surface of the earth that has been subjected to and shows effects of environmental factors such as climate, organisms, topography, parent material, and time.

Scientists that study various aspects of soil are referred to as soil scientists. These men and women study soils in natural landscapes and/or the laboratory to make recommendations and interpretations about soil fertility and plant growth, land use suitability, pollutant fate and transport, soil quality, soil formation, and a host of other soil physical, chemical and biological properties.

Soil Composition

Soil consists of solids, liquids, and gases. The solid material consists of minerals and organic materials. Pores between the solid materials hold liquids and gases that are essential for plant and microorganism growth, and solid materials hold or provide nutrients that can become accessible for organism growth.

During precipitation (rain, snow, etc.), water infiltrates into soil through the pores space and pores become filled. As the soil begins to drain or dry, air replaces water in the pores.

How is Soil Formed?

Soil is formed slowly through the weathering of geologic materials called **parent material**, and parent material is defined as bedrock or unconsolidated mineral and organic matter from which soils develop. As bedrock erodes into smaller particles near the earth's surface, organic matter decays and mixes with inorganic material (rock fragments, soil minerals, water, and gases) to form soil.

The processes of weathering include both physical and chemical weathering reactions.

Physical Weathering

Physical weathering includes the effects of physical factors (temperature, water, and wind) on rock breakdown. For example, frost-wedging occurs when water freezes and expands in a crack within rock. When water enters into a rock and freezes it can expand up to 10% and effectively pry the rock apart. With sufficient time this process can cause the rock to fracture and break into smaller pieces. In addition to daily freeze and thaw of water in the winter, and heating and cooling of rock throughout the year also fractures rock to generate smaller particles.

Chemical Weathering

Chemical weathering occurs when rock dissolves or the composition of a rock changes through chemical processes. The simplest chemical process is called **dissolution** or the dissolving of a rock or mineral. Slightly acidic rain reacting with rock will slowly dissolve rock and release the chemical components of the rock into solution. A second form of chemical weathering involves oxidation-reduction reactions. These reactions involve the transfer of electrons to and from minerals. Most rock-forming minerals contain reduced iron (Fe^{2+}), and when this iron is exposed to oxygen gas (O_2) the iron becomes oxidized (iron loses an electron; Fe^{3+}). This process disrupts the structure of primary mineral and weakens the mineral.

Why are Soils Important?

Soil is essential in the Hydrologic (water), Carbon, and Nutrient Cycles.

The Hydrologic Cycle

A large amount of precipitation falling onto Earth's surface falls directly or indirectly onto soil. Depending on soil factors such as soil moisture status, texture, organic matter content, and soil structure, precipitation may flow into soil where it may be stored for plant use. Additionally, some of the water may percolate downward through the soil or run over the soil surface (surface runoff). Percolation plays an important role in recharging groundwater aquifers. Surface runoff often flows directly into surface water bodies (rivers, streams, and lakes) where it may be used to support aquatic ecosystems and provide sustainable water supplies.

Visit soilsurvey.org

The Carbon Cycle

Soil is an integral component of carbon cycling on Earth. Soil provides a medium for plant growth, letting plants put carbon into their biomass through photosynthesis. When plants and animals die, soil organisms decompose their remains and incorporate a portion of carbon stored within these organisms into soil to form soil organic matter or **humus**. A portion of carbon not incorporated into soil is released to the atmosphere as carbon dioxide (CO_2) via decomposer respiration. Soils have a great capacity to store soil carbon in the form of soil organic matter. Therefore, proper soil management can be used to increase soil organic matter content thus reducing atmospheric CO_2 concentrations. This is very beneficial because CO_2 is a known greenhouse gas that contributes to global warming.

The Nutrient Cycle

Soils have a large capacity to retain and provide nutrients for plant growth. Nutrients in soils may come from atmospheric deposition, plant decomposition, and rock and soil mineral weathering. These nutrients may then be retained on clay surfaces or organic matter where they can be slowly released into soil water. Plants and other organisms can then uptake nutrients from soil water to sustain and enhance growth. However, a portion of these nutrients may be lost from soils or the plant rooting zone through a process called **leaching**.

Visit soilsurvey.org

Five Functions of Soil

1. Medium for Plant Growth

Soil provides a physical substance that supports plants and enhances plant growth. Soil contains pores which allow gases, such as oxygen and carbon dioxide, to enter and escape from soils.

Pores absorb water and retain it for plant use. Deep soils with the proper mixture of sand, silt, and clay can allow plants to survive during periods of drought. To sustain plant growth, soil must provide the following characteristics, which determine its productivity:

- Nutrients (there are 18 plant essential nutrients)
- Aeration (oxygen,O_2)
- Water
- Physical support

2. Habitat for Soil Organisms

Soil provides habitats for soil microorganisms (bacteria, protists, fungi), mammals, worms, insects, and reptiles.

3. Recycling of Nutrients and Organic Wastes

Soil is nature's recycling system for nutrients and organic wastes. Waste and organic materials from plants, animals, and humans are decomposed and assimilated into soils to from humus. Nutrients released during humus formation are converted into usable forms for plants and other organisms.

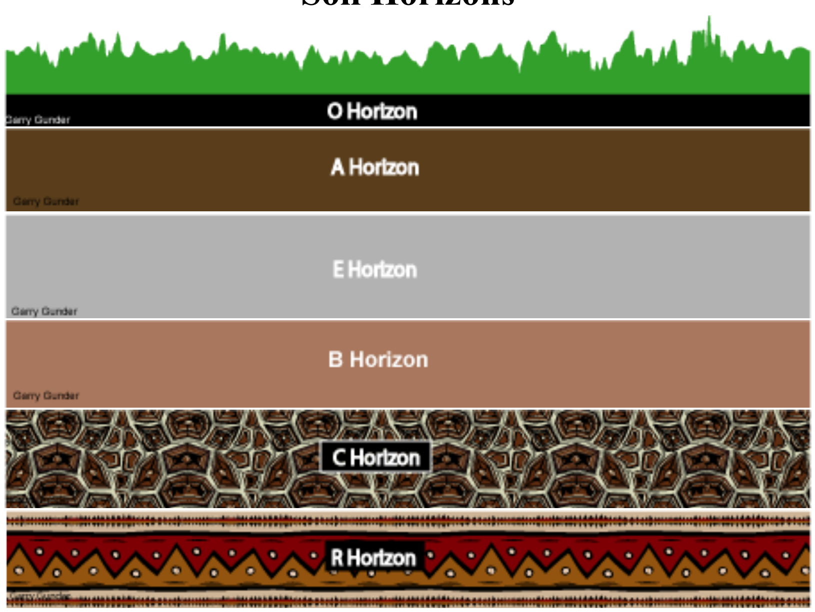
4. Water Supply and Purification

Water that infiltrates into soil during rainfall can be used by vegetation or enter into groundwater aquifers. Pollutants in precipitation or those that enter soil solution upon water infiltration into surface soil horizons can be removed from percolating waters at deeper soil depths, thus purifying and cleansing the water. There are also processes occurring within soil that can kill potential disease-causing organisms.

5. Engineering Medium

Soil is an important building material providing earthen fill and materials to create building materials (bricks), but soil is also the foundation for our daily lives. Soil supplies the foundation for roads, bridges, airports, buildings, and homes. There are numerous soil properties that need to be considered when constructing structures on soil. Engineers must consider the bearing strength, compressibility, sheer strength, and stability of soils. Swelling properties of soils are also important because home foundations and roads can crack due to seasonal soil shrinking and swelling.

Soil Horizons



Soil is made comprised of distinct horizontal layers called **soil horizons**. Horizons in soil range from organic rich surface layers (humus and topsoil horizons) to underlying layers high in rock content (subsoil, regolith, and bedrock).

O Horizon: A surface horizon that is a mix of minerals and organic matter (leaf litter and humus). The organic matter is the dominant material in the O horizon.

A Horizon: A surface horizon that is a mix of mineral and organic matter. Unlike the O horizon, minerals are the dominant material.

E Horizon: A subsurface horizon bleached in color (white or gray) due to loss of minerals that would give it color (iron and aluminum oxides).

B Horizon: A subsoil horizon showing evidence of inorganic or organic material accumulation.

C Horizon: Unconsolidated parent material that has undergone little soil weathering. Most C horizons are mineral layers.

R Horizon: Hard bedrock.

Soil Color

Soil color is one of the easiest physical soil properties to see. Many components in the soil influence soil color, including organic matter, minerals and moisture. Soil color can be an indicator of past environmental conditions.

Importance of Soil Color

Soil color is a variable property, across the landscape and with depth from the surface. Color can tell us much about the soil: the amount of organic matter present; the types of minerals and how weathered they are; the current moisture content; how long water is held in the soil (soil drainage class); and oxidation states of iron and manganese.

Red and yellow colors in the subsoil indicate oxidized iron and tells us if the soil is alternately wet and dry, or if it is dry during the growing season. Gray or blue colors may indicate that soils are wet for much of the year, and any iron present is likely to be in chemically reduced form. Dark colors in the soil, especially at the surface, usually indicate higher amounts of organic matter. These soils can be high in nutrients, have favorable structure, and be easily permeable to air, water and plant roots. Light colored soils may be **leached** (soil constituents such as organic matter, clay, or iron move downward with percolating water faster than they are added from overlying horizons), or contain high amounts of calcium carbonates.

Patterns in soil color can be helpful in determining if a soil is poorly-drained or well-drained. Small spots or "blotches" of contrasting color (called **mottles**) often occur due to oxidized or reduced iron. The brightness or dullness of the **matrix** (the major portion of the soil) and mottles can tell us when water is in the soil, and for how long.

Soil Texture

Perhaps the single most important soil characteristic is soil texture. Texture controls water movement in soil, influences chemical reactivity and nutrient availability, and is a factor in the erosion potential of a soil. Soil texture affects nearly all human use of the soil. There are three individual-sized groups of mineral soil particles—sand, silt and clay (all less than 2 mm in diameter), known as **soil separates**. Soil texture is simply various combinations of the separates, adding up to 100%. Each separate contributes different physical and chemical properties to the soil. Coarser fragments such as gravel and cobbles also affect the character and behavior of the soil.

Soil Separates - Sand, Silt and Clay

Sand particles are the largest of the three soil separates, ranging in size from 0.05 mm to 2.0 mm in diameter. Sand particles can be further divided into five categories, ranging from very fine sand to very coarse sand. Sand particles are visible to the naked eye, and you can feel the individual grains of sand with your fingers. They are often composed of the mineral quartz, SiO_2, although other minerals may be present. The dominance of quartz means that sands contain little in the way of plant nutrients.

Silt particles are between sand and clay in size, and range between 0.002 mm and 0.05 mm. Although they are similar to sand particles in shape and in mineral composition, silt particles cannot be seen with the naked eye. Unlike sand, which feels rough and gritty, silt particles feel smooth like flour or powder. Silt is composed of weatherable minerals, and its smaller size (and increased surface area) allows weathering at rapid enough rates to release significant amounts of plant nutrients.

Clay particles are the smallest of the three separates, less than 0.02 mm in diameter. The have very large surface areas, and carry a negative charge. Because of these two characteristics, clay holds a tremendous amount of water and plant nutrients. Clay soils can be very hard when they are dry, and **sticky** and **plastic** (moldable, like the clay in art class) when wet. There are numerous pores between clay particles but they are so small that air and water cannot move very fast.

Many properties important to plants can be linked to texture and the amount of surface area it provides. (Again, smaller particles have more surface area in relation to their diameter than large particles.) If a soil has more surface area, it can attract and hold more water and plant nutrients. Cohesion, or the tendency to "stick together," is stronger in clayey soils than in sands.

Many soils have particles larger than sand called coarse fragments. Size classes range from pebbles (or gravel, 2 mm to 75 mm), cobbles (75 mm to 250 mm), stones (250 mm to 600 mm), and finally boulders (≥600 mm). Coarse fragments can affect water movement in the soil, or prevent root penetration, and they also occupy volume in the soil that could have been occupied by soil-sized particles.