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Unit Code: T/602/3921 05/24/2023
UNIT GUIDE 2023-24

The Interaction of Soil Environments and Woody Plants

1.1. Describe how a soil is formed

1.2. Identify the role of organic matter in soil formation

1.3. Describe the properties of a minimum of three main constituents of soil

1.4. Describe the effects on the soil of these main constituents

1.5. Identify why aggregates are important to soil structure

1.6. Define the terms soil texture and structure

1.1 Describe how a soil is formed

Soil is the thin layer of material covering the earth's surface and is formed from the weathering of rocks. It is made up mainly of mineral particles, organic materials, air, water and living organisms.

A 'parent material' is a soil-science name for a weathered rock or deposit from and within which a soil has formed. In the UK, parent materials provide the basic foundations and building blocks of the soil, influencing their texture, structure, drainage, and chemistry.

https://www.bgs.ac.uk/datasets/soil-parent-material-model/

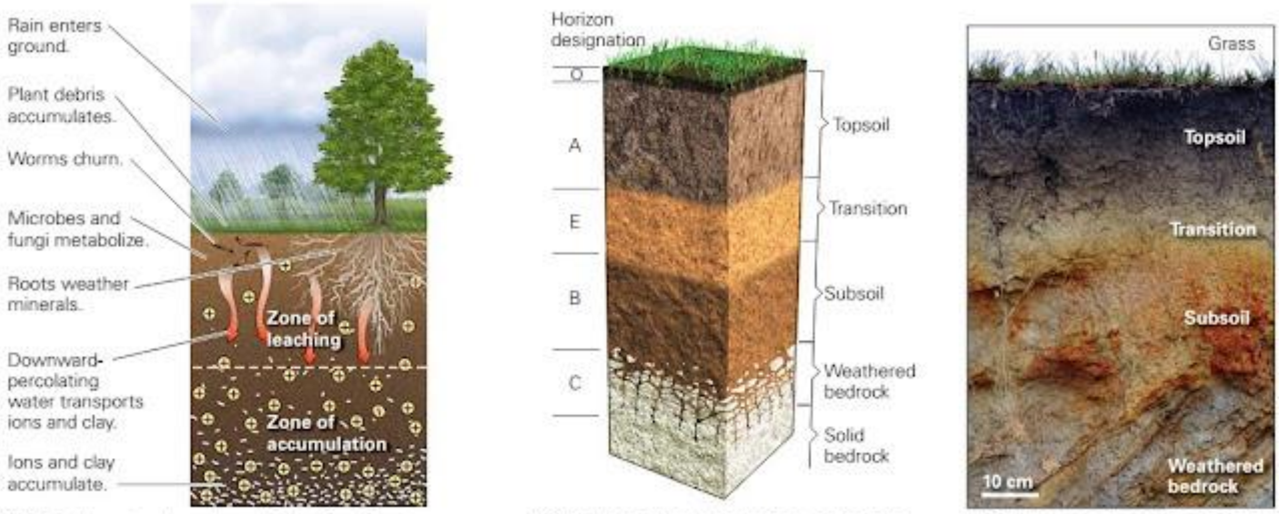
Soil is a mixture of minerals from rocks (45%), organic matter derived from decaying plant and animal material, and organisms the soil (5%), along with air (25%) and water (25%).

As a result of the weathering process that gradually breaks down rocks, soil is continuously but slowly created. Weathering is a process that can be physical, chemical, or biological:

Physical Weathering - Breakdown of rocks by mechanical action. Temperature changes, abrasion (when stones collide with each other), or frost can cause stones to collapse.

Chemical Weathering – Breakdown of rocks due to changes in chemical composition. This can occur when minerals in rocks react with water, air, or other chemicals.

Biological weathering - destruction of rocks by organisms. When animals burrow, water and air are easily drawn into the rock, and plant roots can extend into cracks in the rock and split it.



(a) Soil character depends on climate, for climate controls rainfall and vegetation.

(b) Distinct soil horizons develop, each with a characteristic composition and texture.

(c) Soil horizons exposed on the wall of a gully in eastern Brazil.

http://geologylearn.blogspot.com/2015/11/soil.html

Parent material

It can be bedrock, sand or sediments left by glaciers or rivers. Rocks contain elements useful for plants, such as potassium (K), aluminium (Al), iron (Fe) and manganese (Mn) useful for plant growth. When rocks weather, these elements are released into the newly formed soil.

Climate

Climate affects soil formation through temperature and humidity. Extremely low temperatures freeze the soil and impede its development, while very high temperatures retard soil formation. Temperate climates (mild and usually humid) make the conditions for soil development more favourable. If the soil is too wet, nutrients can dissolve and be transported (leached) deep into the lower soil layers.

Topography

Topography includes elevation, gradient, and exposure. On steep slopes, soil can flow downhill due to gravity, while peat can form in shallow, waterlogged areas of the landscape. Height affects temperature. The mountains tend to be cooler than the lower coastal areas. Mountains can also help form clouds and thus increase rainfall. This is part of the reason growing areas are so humid. In lower areas, the soil tends to be deeper than in highlands, and in general, the steeper the slope, the thinner the soil.

Biota

Soil is an ecosystem for a wide variety of plants, bugs, and microbes to live. Large organisms such as earthworms feed on organic matter near the soil surface and then burrow, excreting organic matter as they move. This releases organic nutrients such as nitrogen (N) and carbon (C) into the soil. Microorganisms (bacteria/fungi) are responsible for breaking down organic matter that enters the soil. Vegetation is also involved in the formation of our soil. For example, acidic waste from pine forests leads to the formation of acidic soil, while waste from deciduous trees raises the pH, making the soil more fertile.

Time

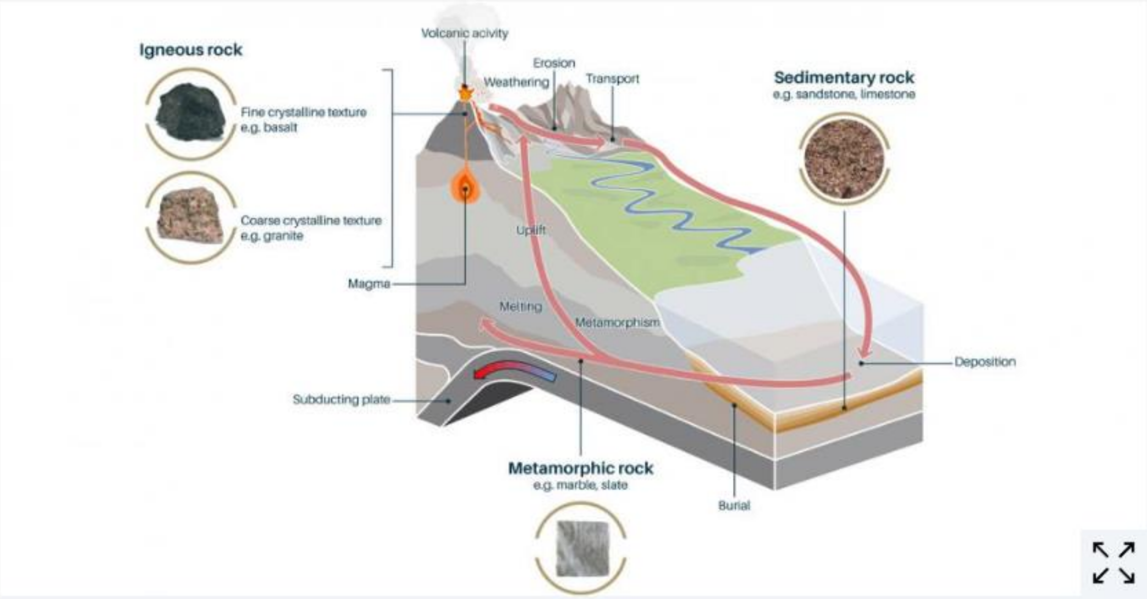
Soils take time to form. The base material weathers depending on the season and temperature. The formation of mountains and erosion change the topography of the earth. Erosion can last for millions of years or can occur suddenly during a storm. It takes time for microorganisms and plants to settle in the soil and begin to mix. All these soil-forming elements work together to form the soil. Therefore, the type of soil in an area is determined by a combination of factors.

A rock is a solid collection of minerals. There are three main types of rock, classified by how they are sourced and formed:

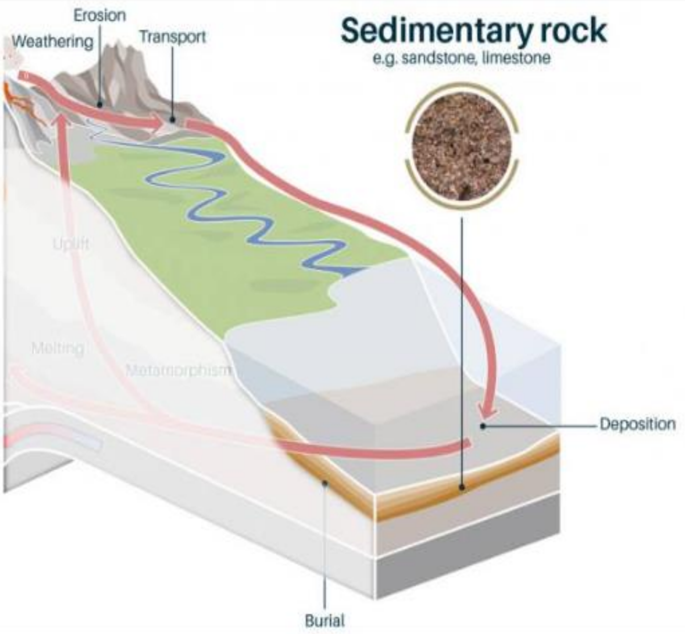
sedimentary

igneous

metamorphic

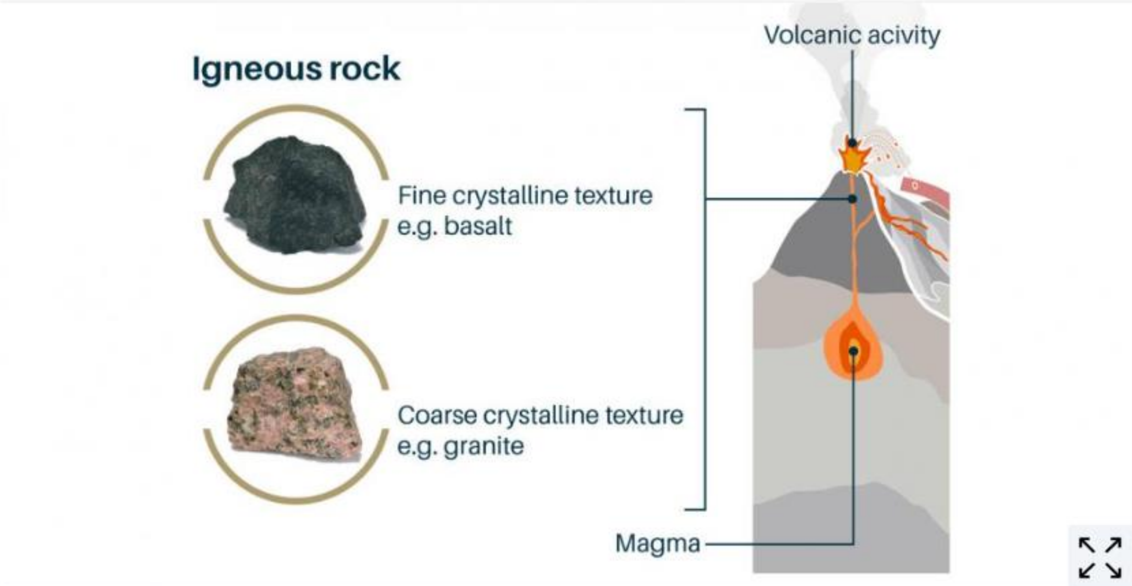


The rock cycle. The diagram shows how the Earth is a dynamic system: all of its parts are connected to each and changes in one part produce a change in another, resulting in a continuous cycle throughout geological time. BGS © UKRI.



Sedimentary rock. The word 'sediment' comes from the Latin words *sedimentum*, meaning settling, or *sedēre*, to sit or sink down.

The processes of weathering and erosion gradually break up rocks into sediments. After sediments are deposited, they can become buried underneath layers of 'fresh' sediments. Over long periods of time, layers of sediments become compacted and cemented, and they are transformed into sedimentary rocks. BGS © UKRI.



Igneous rocks. The word 'igneous' comes from the Latin word *ignis*, meaning fire.

At plate boundaries, or hot spots, some rocks get heated deep inside the Earth and melt into 'molten rock'. Molten rock is called magma when it is inside the Earth and lava when it is on the surface. As it cools, it crystallises and solidifies to form igneous rock. BGS © UKRI.

Metamorphic rock. The word 'metamorphic' comes from the Greek words *meta*, meaning change, and *morph*, meaning shape.

Rocks that are deeply buried, at plate boundaries for example, are subject to intense heat and intense pressure, which produces physical and/or chemical changes in the rock's appearance and structure. BGS © UKRI.

https://www.bgs.ac.uk/discovering-geology/rocks-and-minerals/

The deposition of sediment that has been eroded and weathered from other parent rocks results in sedimentary rocks, which are recycled rocks. They frequently include sand, pebbles, minerals, and mud that have been washed off the land by rivers, blown by the wind, or eroded from it and then eventually deposited.

Sediments can build up in desert environments, though they are typically deposited in lakes and oceans. They frequently form stratified layers. The sediments become compressed into solid rock as younger layers build up one on top of the other.

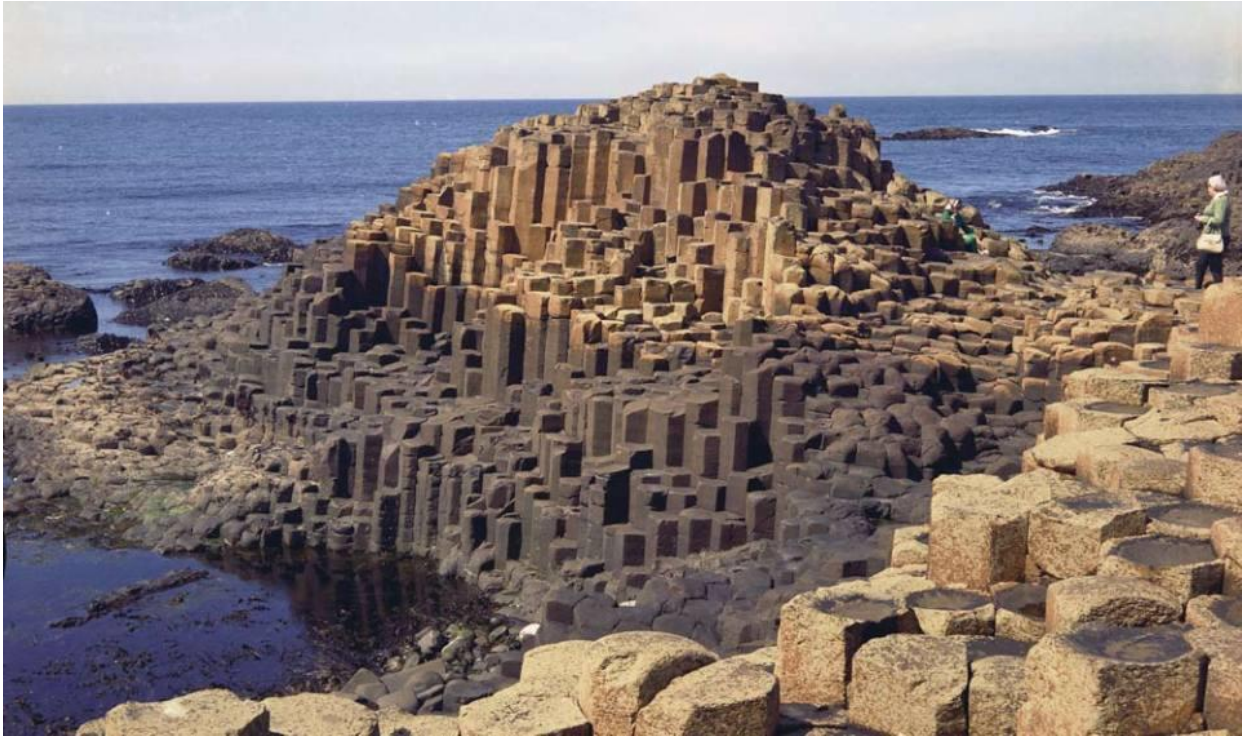
Horizontal layering of sedimentary rocks. Towards the top of the picture there is a layer of sedimentary rock made up of sand and pebbles, deposited between finer-grained rocks. The geological hammer is for scale.

Some sedimentary rocks are formed from deposits on the ocean floor that are almost entirely made up of sea creature shell fragments. Most of the shell's composition is calcium carbonate, and when the shells are compressed, they turn into limestone.

Large amount of dead plant material accumulates, over millions of years, and turns into coal.

Hot molten magma, which originates deep inside the Earth, cools down and forms Igneous rocks. There are two categories of igneous rock: extrusive and intrusive.

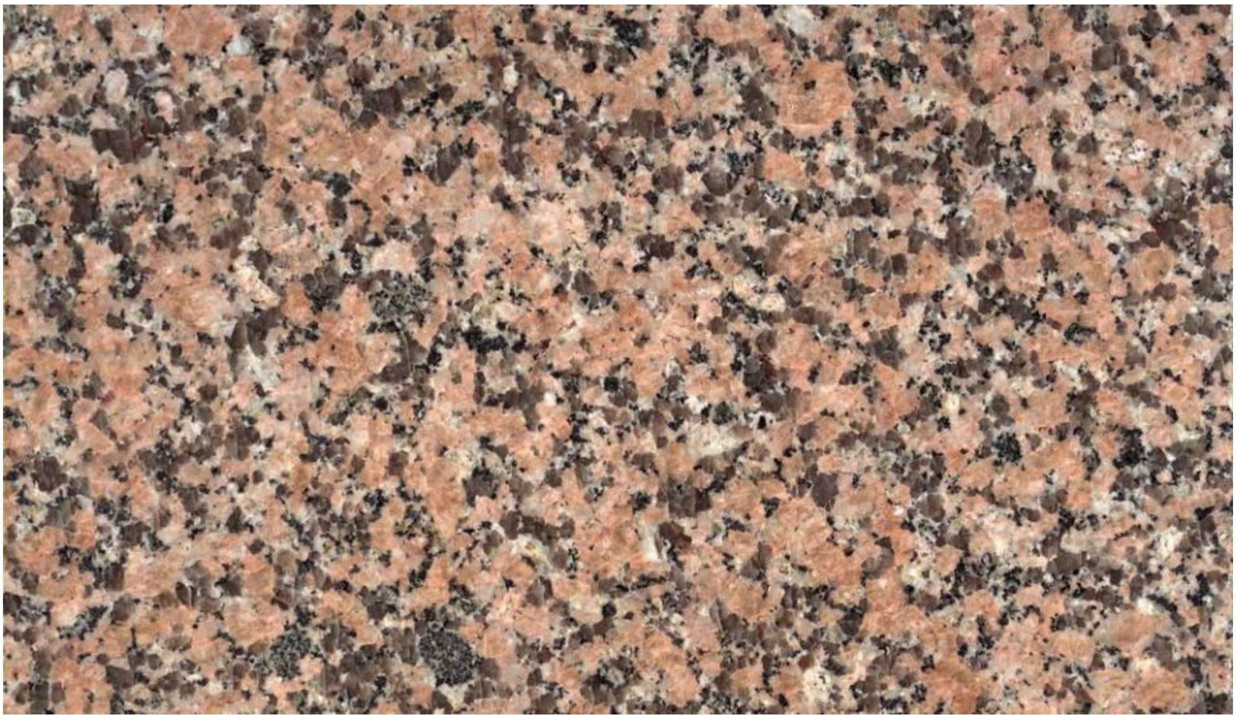
Magma rises towards the surface of the Earth because it is hotter and lighter than the surrounding rock. It can reach the Earth's surface as lava. This process is called extrusion. Due to exposure to air and water it cools quickly and, because of this, the crystals that make it up are usually very small and this is described as fine grained.



The Giant's Causeway in Northern Ireland is an example of extrusive rock. A flow of lava cooled down slowly, developing cracks (known as joints) that created the basalt columns.

Magma which reaches not the surface of the Earth cools down very slowly and deep below the surface — maybe over thousands or millions of years! This process is called intrusion. As a result of the gradual cooling, the crystals form quite large and are therefore visible.

One such rock is granite; it is described as coarse grained is usually light in colour, with clearly visible mineral crystals.



Granite from Peterhead in Scotland. This is an intrusive rock that solidified deep underground, inside a ‘magma chamber.’

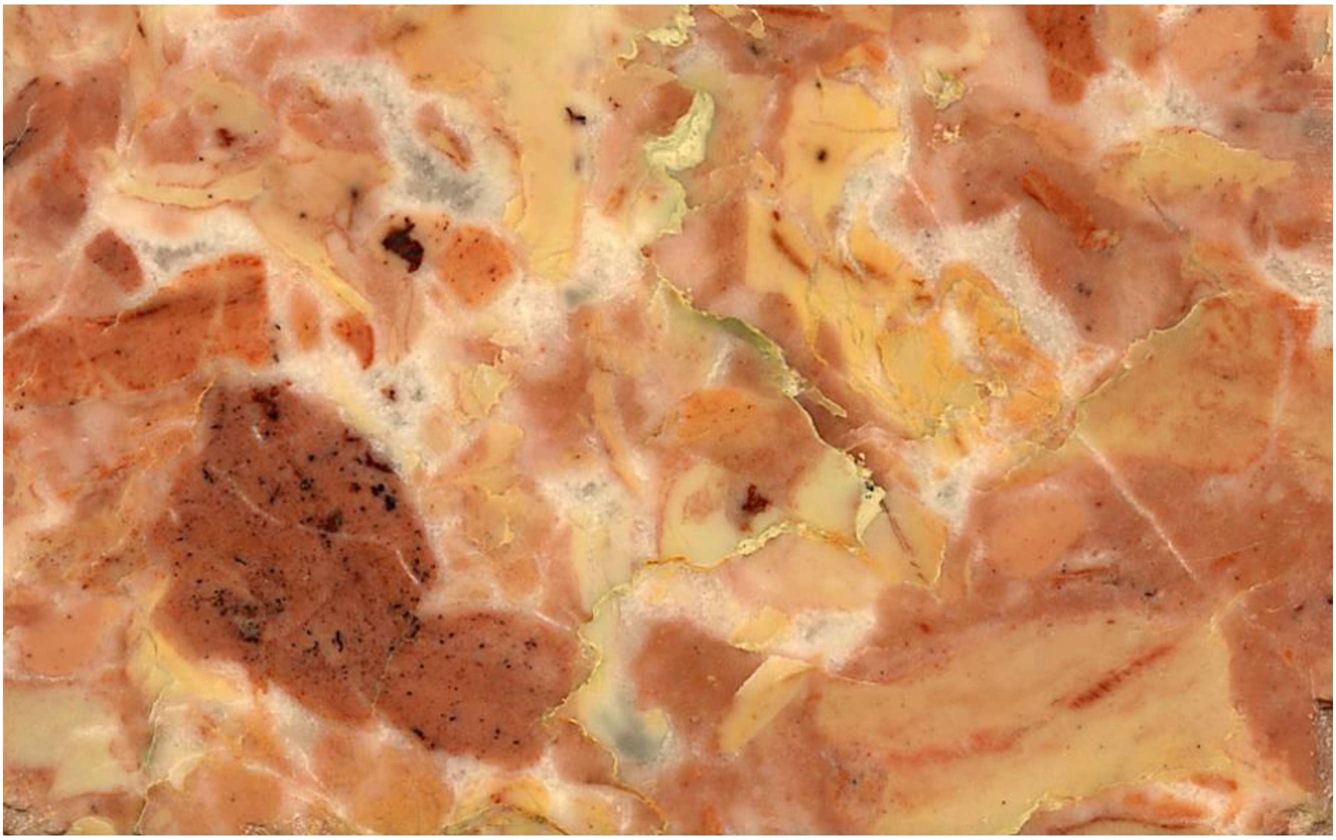
The pinkish minerals are feldspar, the grey, glassy minerals are quartz and the black minerals are biotite mica.

Although granite intrusions initially cooled slowly at depth, uplift, erosion, and weathering over millions of years have caused them to become visible on the Earth's surface today. Metamorphic rocks were originally a sedimentary rock, an igneous rock or even another sort metamorphic rock.

Metamorphism means ‘change in form.’ Deeply buried underground rocks may be exposed to extreme pressures and temperatures. Being in these environments for millions of years will change the rocks physically or chemically (or both).

The process of already-buried rocks becoming "baked" or "cooked" when they encounter hot igneous material is referred to as "contact metamorphism."

Limestone undergoes metamorphism, which causes it to become harder and more crystalline and transform into marble. A shale rock may transform into slate when it undergoes metamorphism.


Marble is a metamorphic rock that was originally a carbonate-rich rock, such as a limestone.

Minerals

A mineral is a naturally occurring substance with distinctive chemical and physical properties, composition, and atomic structure.

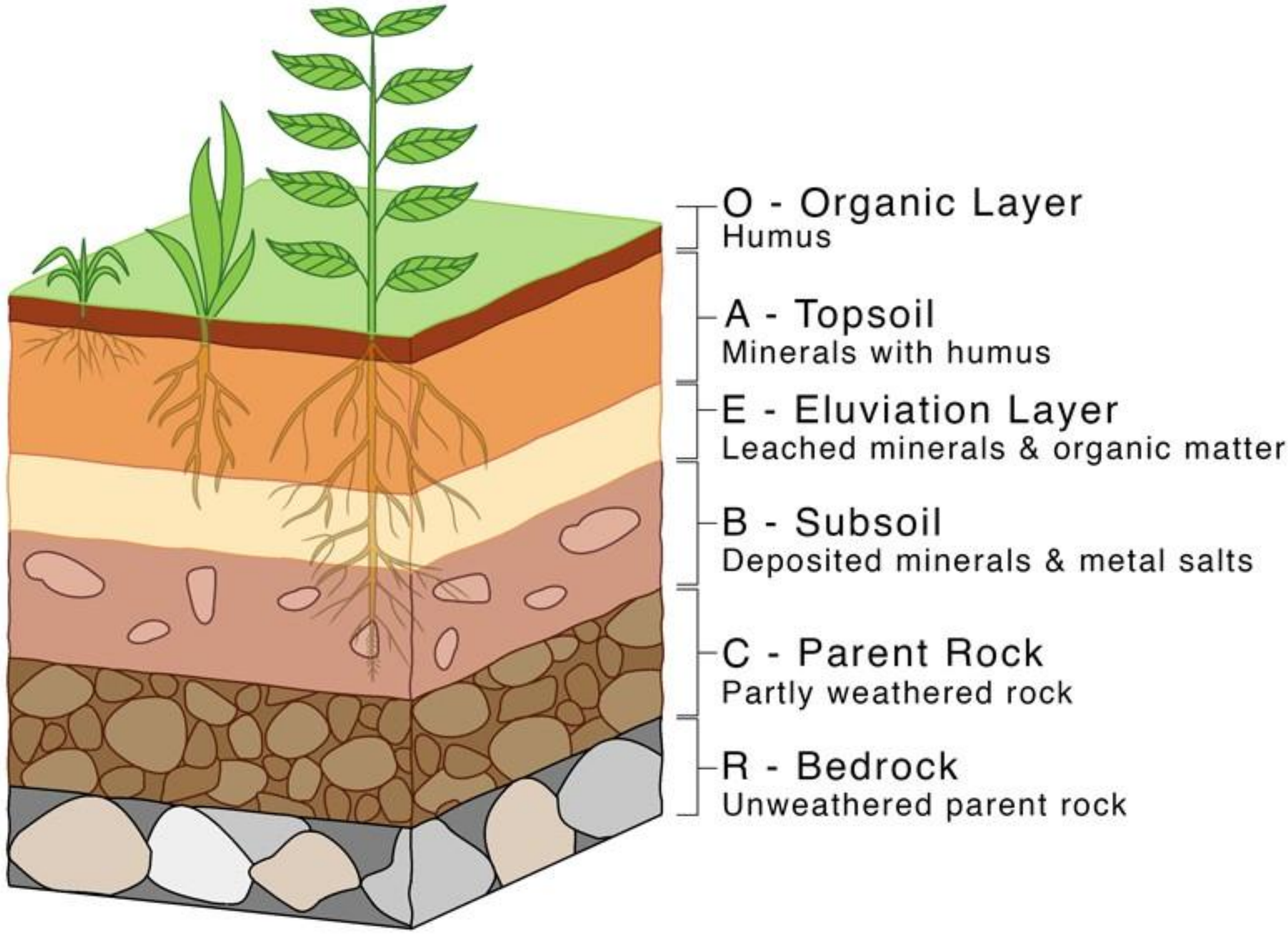
Usually, two or more minerals are bonded together through geological processes to form rocks. For example, granite is an igneous rock mostly made from different proportions of the minerals quartz, feldspar, and mica as interlocked crystals; a sandstone is a sedimentary rock that can also contain quartz, feldspar, and mica, but as grains compacted and cemented into each other.

The concept of an economic mineral is more expansive. Economic minerals are extracted from the Earth through quarrying, mining, and pumping and used in a variety of processes related to building, manufacturing, agriculture, and energy supply. They include: minerals, metals, rocks like building stones and aggregates, hydrocarbons: both solid, like coal, and liquid, like petroleum.

https://www.bgs.ac.uk/discovering-geology/rocks-and-minerals/

Soil Profile

Soils develop layers (horizons) over time. The vertical cross-section of the soil is known as soil profile.



https://www.sciencefacts.net/soil-horizons.html

Soil Profile

The different layers of soil are topsoil, subsoil, and parent rock.

Topsoil is usually referred to as A horizon where most plants, roots, earthworms, insects, and microorganism are active.

Subsoil is usually referred to as B horizon which can be clay rich but often is less fertile than the topsoil but can hold more moisture.

Organic Horizon is mostly made up of decomposed organic matter, including grasses, dead leaves, dried leaves, tiny boulders, twigs, surface creatures, and fallen trees. This soil horizon frequently has a dark brown or black colour, which is mostly due to the presence of organic material.

A Horizon or topsoil contains decomposed organic matter (humus). This horizon is composed mostly of minerals from parent material, with some organic matter incorporated into the mix. Topsoil functions as a great source of material for plants and other living organisms to live off.

B Horizon, or subsoil is made up of mineral layers that have been considerably changed by pedogenesis, most notably by the production of iron oxides and clay particles. It is often brownish or reddish in colour due to iron oxides, which raise the chroma of the subsoil to the point that it can be recognised from the other horizons.

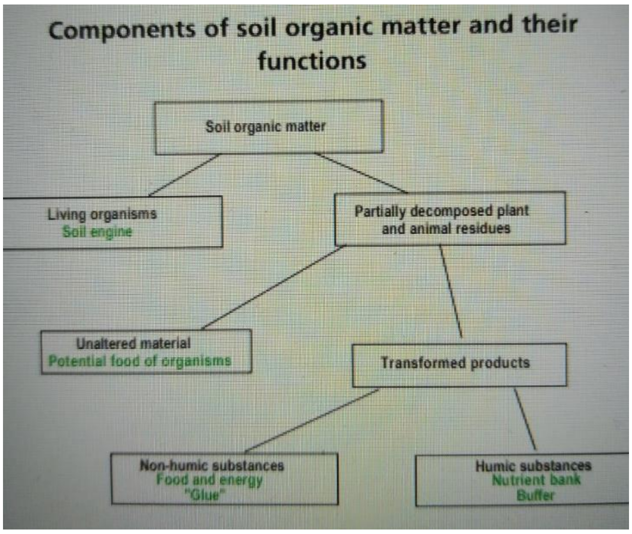
C Horizon (parent material): This layer of soil has little to no evidence of weathering or other alterations of the soil particles.

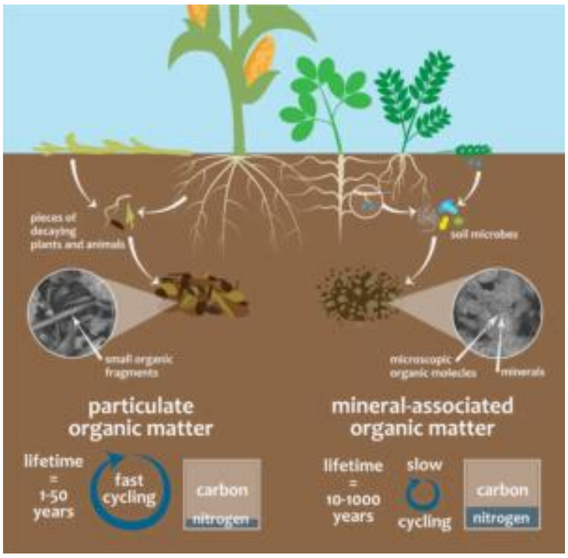
R Horizon (bedrock): This layer of soil is the unweathered parent material and is made up of a mass of rock such as granite, basalt, quartzite, limestone, or sandstone and cemented by the weight of the above layers.

<u>1.2. Identify the role of organic matter in soil formation</u>

Soil organic matter is any material produced originally by living organisms (plant or animal) that is returned to the soil and goes through the decomposition process. At any given time, it consists of a range of materials from the intact original tissues of plants and animals to the substantially decomposed mixture of materials known as humus.

https://www.fao.org/3/a0100e/a0100e04.htm





https://www.iokamarketing.com/profit-above-ground-wealth-below-ground/

Most soil organic matter originates from plant tissue. Plant residues contain 60–90 percent moisture. The remaining dry matter consists of carbon (C), oxygen, hydrogen (H) and small amounts of sulphur (S), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg). Although present in small amounts, these nutrients are very important from the viewpoint of soil fertility management. Soil organic matter consists of a variety of components. These include, in varying proportions and many intermediate stages, an active organic fraction including microorganisms (10–40 percent), and resistant or stable organic matter (40–60 percent), also referred to as humus.

For practical purposes, organic matter may be divided into aboveground and belowground fractions. Aboveground organic matter comprises plant residues and animal residues. Belowground organic matter consists of living soil fauna and microflora, partially decomposed plant and animal residues, and humic substances.

Organic matter existing on the soil surface as raw plant residues helps protect the soil from the effect of rainfall, wind, and sun. Removal, incorporation or burning of residues exposes the soil to negative climatic impacts, and removal or burning deprives the soil organisms of their primary energy source.

Organic matter within the soil serves several functions. From a practical agricultural standpoint, it is important for two main reasons: as a “revolving nutrient fund,” and as an agent to improve soil structure, maintain tilth and minimize erosion. As a revolving nutrient fund, organic matter serves two main functions: As soil organic matter is derived mainly from plant residues, it contains all the essential plant nutrients. Therefore, accumulated organic matter is a storehouse of plant nutrients. The stable organic fraction (humus) adsorbs and holds nutrients in a plant available form. Organic matter releases nutrients in a plant-available form upon decomposition.

In order to maintain this nutrient cycling system, the rate of organic matter addition from crop residues, manure and any other sources must equal the rate of decomposition, and consider the rate of uptake by plants and losses by leaching and erosion. Where the rate of addition is less than the rate of decomposition, soil organic matter declines.

Importance of Nutrient Cycling

All living organisms, biomolecules and cells are made up of carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus. These elements are essential for life. It is important to recycle and continuously replenish nutrients into the environment for life to exist.

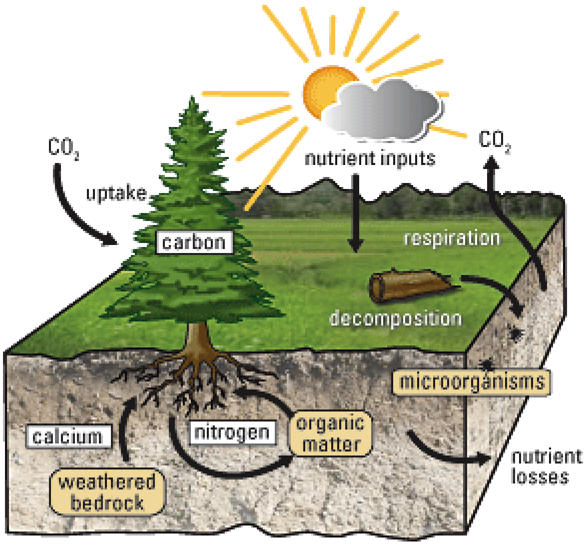
Nutrient cycling is important for:

It is required for the transformation of nutrients from one form to another so that it can be readily utilised by different organisms, e.g., plants cannot take atmospheric nitrogen and it must be fixed and converted to ammonium and nitrate for uptake.

Transfer of nutrients from one place to another for utilisation, e.g., air to soil or water

Nutrient cycles keep the ecosystem in equilibrium and help in storing nutrients for future uptake

Through nutrient cycling, living organisms interact with the abiotic components of their surroundings



https://mdocs.skidmore.edu/crandallparktrees/ecosystem/nutrient-cycling/

1.3. Describe the properties of a minimum of three main constituents of soil

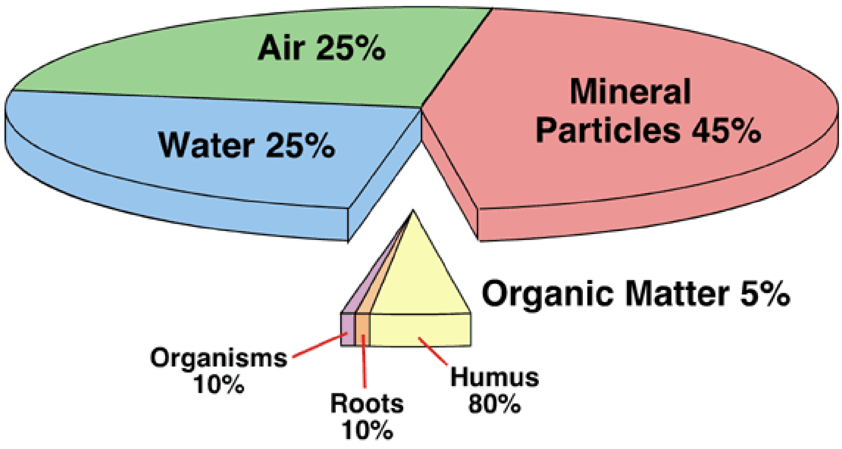
The four components of soil include:

mineral matter – 45%

organic matter – 5%

air – 25%

water – 25%



http://www.physicalgeography.net/fundamentals/10t.html

Minerals

Mineral

Component of rocks. A naturally occurring inorganic solid with a crystalline structure and a specific chemical composition.

The mineral portion of the soil is obtained from the bedrock from which it was formed. Some of the mineral particles, such as sand, still consist of rock. They are chemically and structurally the same as the parent rock, but have been ground by weather, water, glaciers, and other natural forces into small pieces. Other particles—including most of the microscopic clay particles—have been dissolved and broken down again, many times, to reach a form that is quite different from the native rock.

Minerals in soil are important for several reasons:

They provide volume and mass to the soil;

As they weather, they supply elements that are required to grow plants;

As they weather, they provide the materials to form other minerals.

Some of the most common minerals found in soil are, Iron, Potassium, Magnesium, Calcium, Sulphur etc.

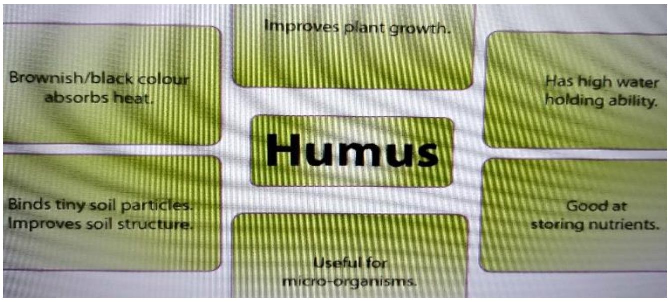
Organic matter

Organic Matter

Mass of matter that contains living organisms or non-living material derived from organisms.

Living and dead plant and animal matter in various stages of growth and decay constitute the organic part of the soil. Most native, or unamended, soils contain from less than 1% to 5% organic matter, whereas a well-amended garden soil may contain 30% or more. Adding organic matter is one of the best things you can do to your soil. In addition to being a reservoir of nutrients, organic matter improves the soil structure .

Humus is the organic substances that are formed due to decomposition of dead and decomposing plants and animals. The humic substances make up about 60-80 % of the soil organic matter.



https://gamesmartz.com/definitions?definition=5169&humus&s=80

Live organic matter includes earthworms, insects, microorganisms, and plant roots. Earthworms and plant roots perform a valuable service by creating tunnels for air and water to flow through the soil. An invisible world of soil bacteria, fungi, and algae is even more crucial. These microorganisms decompose organic matter and contribute to the chemical reactions that allow plants to absorb nutrients.

Water

Soil acts as a sponge to take up and retain water. Soil water enables plants to absorb minerals by first dissolving them. Water is also needed for the physiological and chemical processes of plant growth.

The numerous forms of water that can be found in the soil are as follows: Capillary Water. This water moves in films; generally, from field capacity to dry air. Hygroscopic Water. This water is held they most tightly; find it between air or oven dry. Gravitational Water. This water moves in response to gravity, or it is not held in the soil.

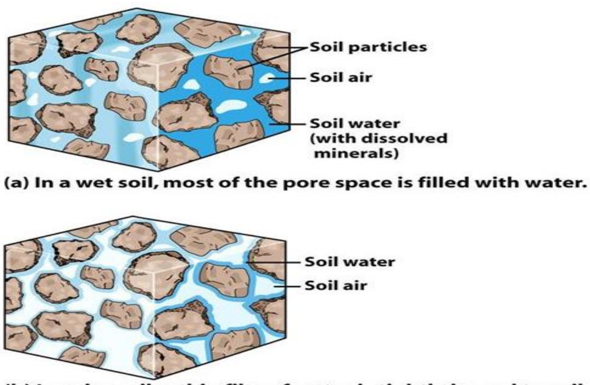
Soil Movement of water into soil is called infiltration, and the downward movement of water within the soil is called permeability.

Pore space in soil is the conduit that allows water to infiltrate and filter (percolate). It also serves as the storage compartment for water.

Water is so strongly attracted to small spaces, or pores, in the soil that it moves from large spaces to smaller ones, even if the movement is upward or sideways. That is why a soil with mostly small pores, such as clay, holds water so well. An ideal soil has a mix of large and small spaces, so that it holds both water and air.

Air

Soil is an organism that breathes in and out. Soil with a loose surface and large pores permits air to diffuse easily into it. Entry is limited if the soil is crusted over or compacted. Pores not filled with water are filled with soil air: a mixture of 79% nitrogen, less than 20.6% oxygen, and generally more than 0.2% carbon dioxide (CO_2)[1]. The air in soil is in constant exchange with the atmosphere. Soil air is more humid than the air that humans breathe, and it has a higher carbon dioxide content. The oxygen it contains is vital to the root growth of plants. In fact, roots grow only where oxygen is present in the soil. Roots and decaying organic matter give off carbon dioxide, which diffuses to the surface and dissipates in the air as oxygen diffuses to the depths of the soil.



(a) In a wet soil, most of the pore space is filled with water.

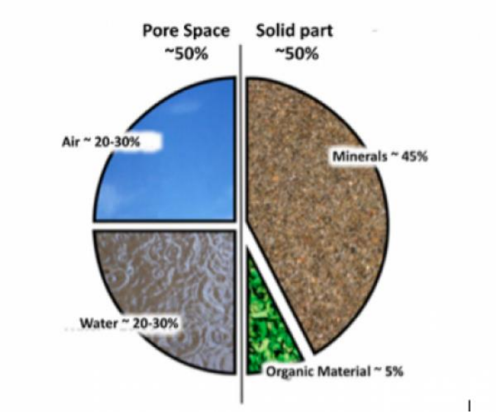
(b) In a dry soil, a thin film of water is tightly bound to soil particles, and soil air occupies most of the pore space.

1: Blum. Bodenkunde in Stichworten. 6th edition.

1.4. Describe the effects on the soil of these main constituents

The basic components of soil are minerals, organic matter, water, and air. The typical soil consists of approximately 45% mineral, 5% organic matter, 20-30% water, and 20-30% air.

The pie chart showing the typical physical composition of most soils.



https://www.e-education.psu.edu/geog3/node/1029

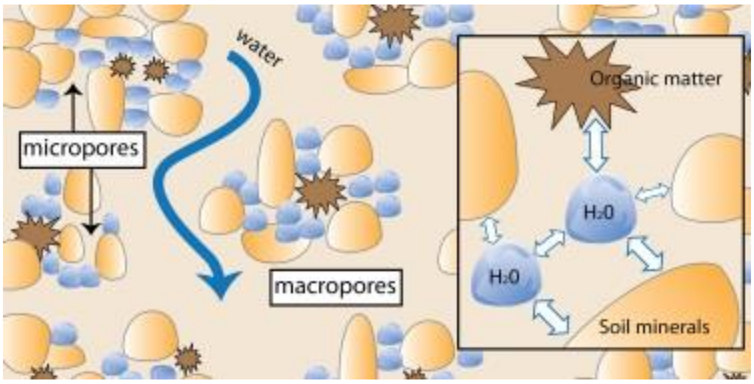
The soil components can be divided into two categories. Biotic factors are all living and once-living things in soil, such as plants and insects. Abiotic factors include all non-living things, such as minerals, water, and air. In soil, phosphorus, potassium, and nitrogen gas are the most common minerals that support plant growth. Sulphur, calcium, and magnesium are fewer common minerals. A soil's composition is determined by its biotic and abiotic factors.

Soil minerals

Soil minerals weather, break down, and dissolve, releasing nutrients that plants can take up. Primary minerals persist with little change in composition. It is the basic particles that are the result of weathering of rocks. It contains the inorganic salts found in the soil. Mineral matter differs in size in different types of soil. Mineral nutrients are essential for maintaining the structure and function of cells and organelles, as well as producing enzymes and compounds. Minerals in soil provide both sources and sinks of nutrients for plants. As primary minerals that originally formed at high temperatures and pressures in igneous and metamorphic rocks are weathered in soils, they release plant nutrients into the soil solution.

Soil water

The supply of water through soils is crucial for the survival of both plants and soil organisms. Soil water contains nutrients that move into the plant roots when plants take in water. Water enters the soil through macropores and is stored in many micropores. Porous soils have a balance between macro and micro pores.



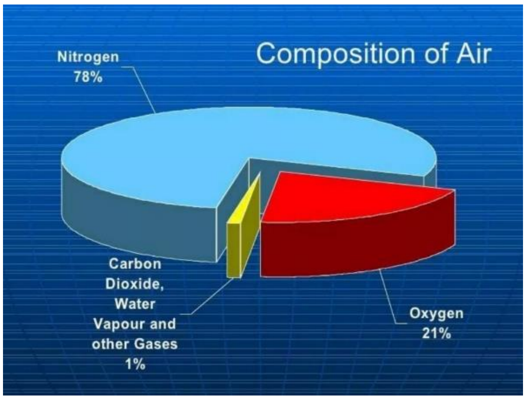
https://www.qld.gov.au/environment/land/management/soil/soil-properties/water#:~:text=Water%20supply%20through%20soils%20is,many%20small%20pores%20(micropores).

Pores are classified as micropores for holding water and macropores for holding air or water for a short period of time. The number of pores is important for agricultural production, but so is the ratio of micropores to macropores. The best ratio ranges from 3:2 to 1:1. Total porosity on agricultural land ranges from 50 to 65%.

Water is a strong soil formation agent. Its absence causes soluble salts and carbonates to build and dense subsoil horizons to form in dry conditions. When soil moisture levels rise again, water may pool above or below these dense layers. Water-saturated soils have a low oxygen level, which influences soil chemistry and restricts microbial activity.

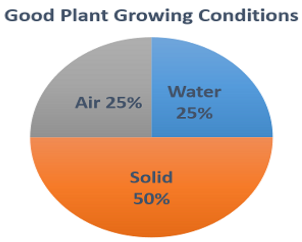
Water is also a cause of soil erosion on the soil's surface. Water can move soil particles from one spot to another during heavy rainfall. When the soil surface remains uncovered, soil grains disintegrate and wash into streams, where they are taken away.
Retained water serves as a significant moisture reservoir and can take two forms: it can be adsorbed to the soil matrix or it can be kept in the capillary gap between individual soil particles. Plant roots must overcome binding forces that keep the water in place in order to gain access to this reservoir. Water trapped in microscopic micropores is frequently inaccessible because the binding forces are high for root suction to overcome.
Soil water is most accessible when the pores in the soil range from 0.2 to 50 m3. This means that silt soils have a suitable texture in which water is retained in the pore space but is not as tightly bound. As a result, roots require less suction and water becomes plant-available. However, the soil is more than just a water reservoir for plants.
Soil plays an important role in the global water cycle by filtering contaminants from soil solutions and releasing filtered water for groundwater recharge. Water is the life-giving liquid in and around the soil.

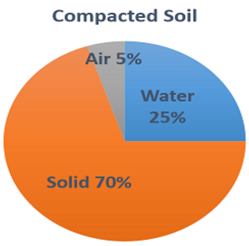
Soil Aeration: Oxygen and other gases

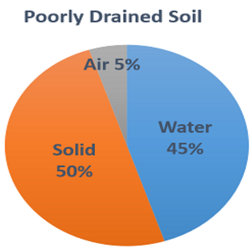


Soil Air Composition: Soil air consists of a variety of gases, the most essential of which are nitrogen, oxygen, carbon dioxide, and water vapor.
Soil air is constantly moving from the soil pores into the atmosphere and back into the soil pores.
Soil gases are the gases found in the air space between soil components. The spaces between the solid soil particles, are filled with air, if they do not contain water, The primary soil gases are nitrogen, carbon dioxide and oxygen. Oxygen is critical because it allows for respiration of both plant roots and soil organisms. Other natural soil gases include nitric oxide, nitrous oxide, methane, and ammonia.
Gases fill soil pores in the soil structure as water drains or is removed from a soil pore by evaporation or root absorption. The network of pores within the soil aerates, or ventilates, the soil. This aeration network becomes blocked when water enters soil pores. Not only are both soil air and soil water very dynamic parts of soil, but both are often inversely related.

Proportions of soil components (on a volume basis) under different plant growing conditions:







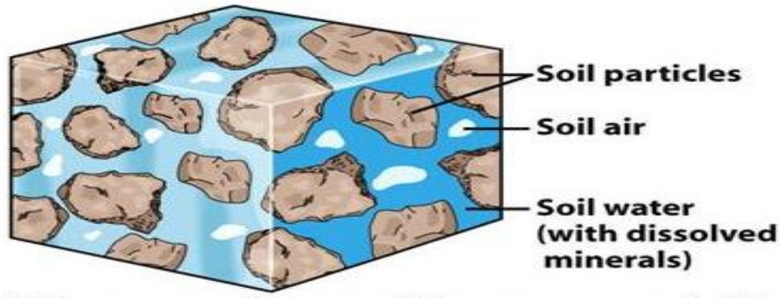
https://wiki.ubc.ca/LFS:SoilWeb/Soil_Components/Soil_Air

The quantity and mix of air in soil are constantly shifting and greatly affected by water content and soil organism activity. Atmospheric air and soil air differs. Soil air contains more moisture than the atmosphere, with relative humidity approaching 100% under ideal conditions (humidity in soil is not as variable as it is in the atmosphere).

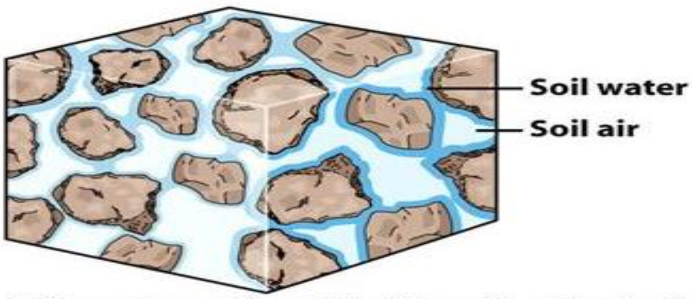
Composition of soil air and atmosphere:
Nitrogen: Soil Air (79.2%) Atmosphere (79.0%)
Oxygen: Soil Air (20.6%) Atmosphere (20.9%)
Carbon Dioxide: Soil Air (0.25%) Atmosphere (0.03%)

https://wiki.ubc.ca/LFS:SoilWeb/Soil_Components/Soil_Air

Soil air's oxygen is essential for plant root growth. Roots grow only where there is oxygen in the soil.
Carbon dioxide is released by roots and decaying organic matter, which disperses to the surface and evaporates in the air while oxygen diffuses to the soil's depths.



(a) In a wet soil, most of the pore space is filled with water.



(b) In a dry soil, a thin film of water is tightly bound to soil particles, and soil air occupies most of the pore space.

https://slideplayer.com/slide/13461000/

Plant roots and microorganisms both require oxygen for breakdown and create carbon dioxide as a waste product, among other gases. Carbon dioxide emerges and remains in the soil pore space until it slowly diffuses into the atmosphere.

<u>Soil organic matter</u>

Soil organic matter is the soil's organic component. It is made up of organic material from plants and animals, as well as material converted by microorganisms in the soil at various stages of decomposition. Organic matter in soil has a direct impact on agriculture and forestry production.
Healthy soils with steady amounts of organic matter are also better suited to preventing and combating soil-borne diseases. Soil organic matter is important for improving soil fertility and quality on three levels:

Chemical:
Soil organic matter significantly improves the soil's capacity to store and supply essential nutrients (such as nitrogen, phosphorus, potassium, calcium, and magnesium), and to retain toxic elements. It allows the soil to cope with changes in soil acidity, and helps soil minerals to decompose faster.

Physical:
Soil organic matter improves soil structure. Organic matter in the soil promotes soil structure.
This, in turn, serves to limit soil erosion and enhances water infiltration and holding capacity, providing better living conditions for plant roots and soil organisms.

Biological:
Organic matter in the soil is a key source of carbon (C), which provides energy and nutrients to soil organisms.
This enhances soil functionality by increasing the activity of microorganisms in the soil and can increase biodiversity.
Capturing carbon in the soil also reduces CO2 emissions into the atmosphere, which helps to prevent climate change.

1.5. Identify why aggregates are important to soil structure

Soil aggregates are part of soil structure and function as well as support aeration and drainage, reduce erosion and runoff, and promote rooting, soil fertility and productivity.

The formation of soil aggregates is a comprehensive process that includes physical, chemical, and biological processes that is taking place below ground. They are also influenced by human factors, like tilling, walking on the surface and others.

Each aggregate is made up of soil particles of different sizes held together by both the attraction of soil particles and the binding of organic matter between soil particles.

Soil aggregates are consequently stabilized naturally by the accumulation of organic matter produced by microorganisms such as fungi, whose hyphae hold soil particles together and generate a glycoprotein (glomalin) cementing agent that helps bond primary soil particles.

Soil structure is most usefully described in terms of grade (degree of aggregation), class (average size) and type of aggregates (form).

The arrangement of soil aggregates into different forms gives a soil its structure. The natural processes that aid in forming aggregates are:

1) wetting and drying,

2) freezing and thawing,

3) microbial activity that aids in the decay of organic matter

4) activity of roots and soil animals, and

5) adsorbed cations.

The wetting/drying and freezing/thawing action as well as root or animal activity push particles back and forth to form aggregates. Decaying plant residues and microbial by-products coat soil particles and bind particles into aggregates. Adsorbed cations help form aggregates whenever a cation is bonded to two or more particles.

Natural aggregates that can be clearly seen in the field are called peds. Clods, on the other hand, are aggregates that are broken into shape by artificial actions such as tillage.
The surfaces of peds persist through cycles of wetting and drying in place. Commonly, the surface of the ped and its interior differ as to composition or organization, or both, because of soil development.
Earthy clods and fragments stand in contrast to peds, for which soil forming processes exert weak or no control on the boundaries.
Peds are made up of mineral particles (clay, silt, sand) and organic matter. Peds are held together by the electrical charges on the surfaces of the minerals and organic matter.

Although clay particles are small, they have large surface areas. For example, the surface on the clay in a teaspoon of black cracking clay soil is equal to the surface area of a tennis court.

Such clays and soils with a lot of organic matter are more likely to form strong peds. Sandy soils or soils with little organic matter often have little or no ped development.

Peds are described by their shape—for example: blocky, columnar, massive, single grain or platy.

Structure is very important since (along with soil texture) it affects the porosity of the soil. A dense structure will greatly reduce the amount of air and water than can move freely through the soil. Also, it will affect the plant's ability to propagate roots through the soil. There are five major classes of structure seen in soils: platy, prismatic, columnar, granular, and blocky. There are also structureless conditions. Many types of soil aggregates occur in soils with four principal shapes being spheroidal, platy, block-like, and prism-like.

Spheroidal (granular)

Aggregates are usually between 2 mm and 1 cm in diameter and have rounded vertices. Usually present in surface horizons that have high organic matter content and abundant roots. This type of structure stimulates rapid water infiltration.

Plate-like

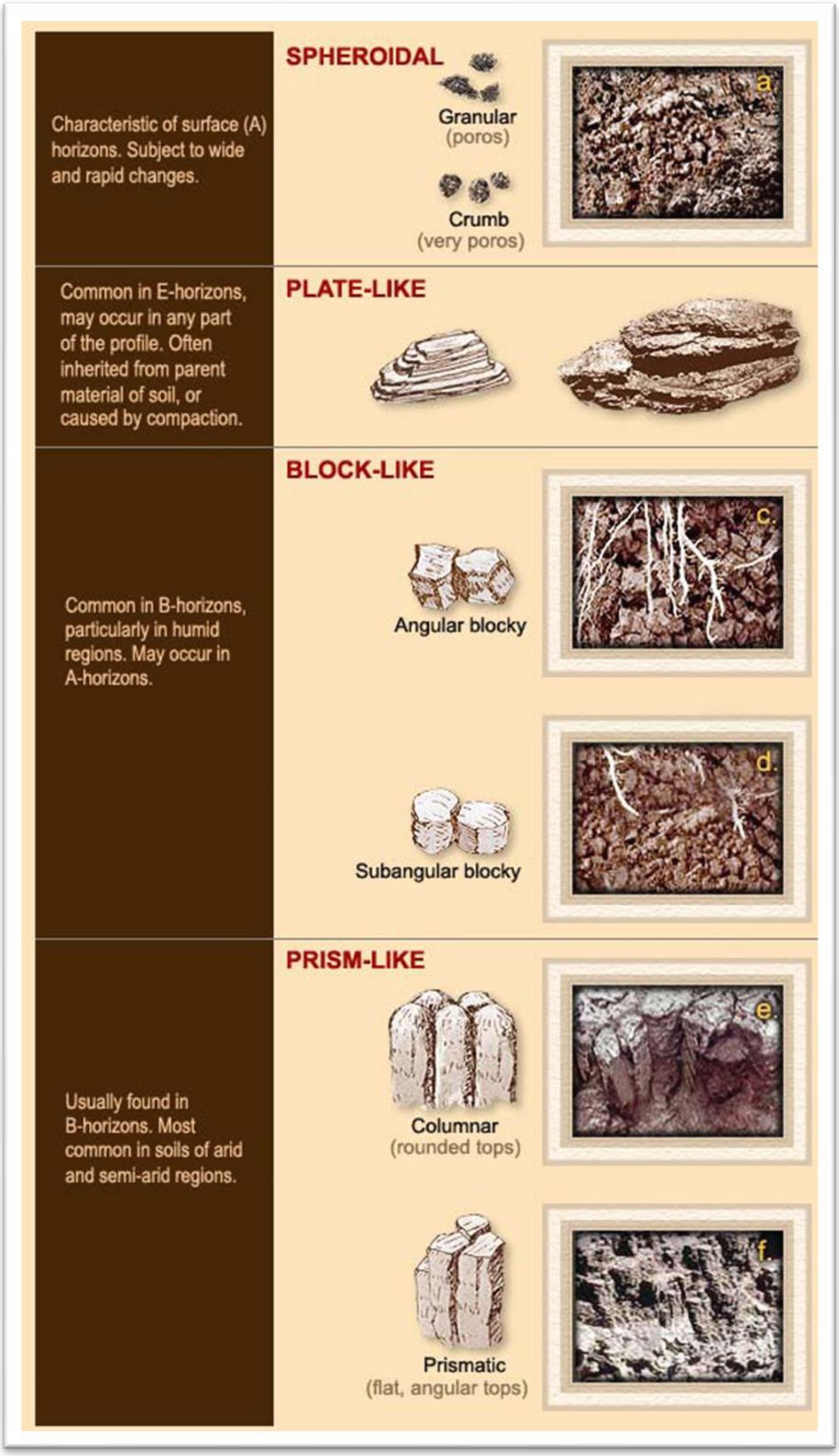
Aggregates are thin flat plates that lie horizontally. Usually present in compacted soils, or clay deposits. This type of structure stimulates slow water infiltration.

Block-like

Aggregates are shaped as irregular blocks of 1.5 to 10.0 cm in diameter. *Angular blocky* aggregates have flat faces and sharp edges, while *sub-angular blocky* aggregates have sub-rounded edges. This type of structure stimulates moderate water infiltration.

Prism-like

Aggregates are shaped as vertical columns. Aggregates that have well-defined vertical faces and sharp edges are referred to as *prismatic*, while those that have vertical edges near top of columns rounded (or irregular) are called *columnar*. These aggregates are usually present in B horizons. This type of structure stimulates moderate water infiltration.



https://wiki.ubc.ca/LFS:SoilWeb/Interactions_Among_Soil_Components/Soil_Structure

1.6. Define the terms soil texture and structure

A soil can be categorised in two fractions: the coarse fraction and the fine earth fraction.

The coarse fraction of soil includes any soil particles greater than 2mm. The coarse fraction includes boulders, stones, gravels, and coarse sands. The rocky particles are a combination of more than one type of mineral.

Soil minerals (fine earth fraction) are divided into three classes of size: clay, silt, and sand. The percentage of particles in these size classes is called **soil texture**.

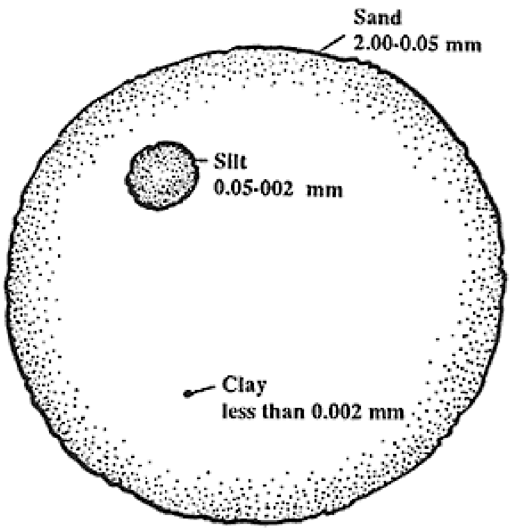


Table 1. Description of sand, silt, and clay classes.

The Fine Earth Fraction			
	Size	**Texture**	**Characteristics**
Sand	2.0 mm -0.05 mm	gritty	Sand is visible to the naked eye, consists of particles with low surface area, and permits excessive drainage. Sandy soil is a dry soil with lots of air in it. Like the name suggests, sandy soil is mostly made up of sand. Because of the fine grains, water drains easily through this soil and makes it stays dry. It is an easier soil to dig with but it means any plants growing here will need to be well watered. It usually has less organic material in it so needs fertiliser to provide any plants with nutrients.
Silt	0.05 mm - 0.002 mm	buttery	Silt is not visible to the naked eye and increases the water holding capacity of soil.
Clay	< 0.002 mm	sticky	Clay has a high surface area, high water holding capacity, many small pores, and possesses charged surfaces to attract and hold nutrients.

			Clay soil is sticky and does not have much air in it. It tends to hold a lot of water. Clay is a difficult soil to work with, clay-based soils are known for being cloddy thanks to their ability to hold on to water. This means they can become waterlogged and muddy all too easily or in hot countries dry out and crack making it difficult to grow anything.

https://www.nature.com/scitable/knowledge/library/what-are-soils-67647639/#:~:text=Soil%20minerals%20are%20divided%20into,classes%20is%20called%20soil%20texture.

Loam soil is somewhere between clay and sand

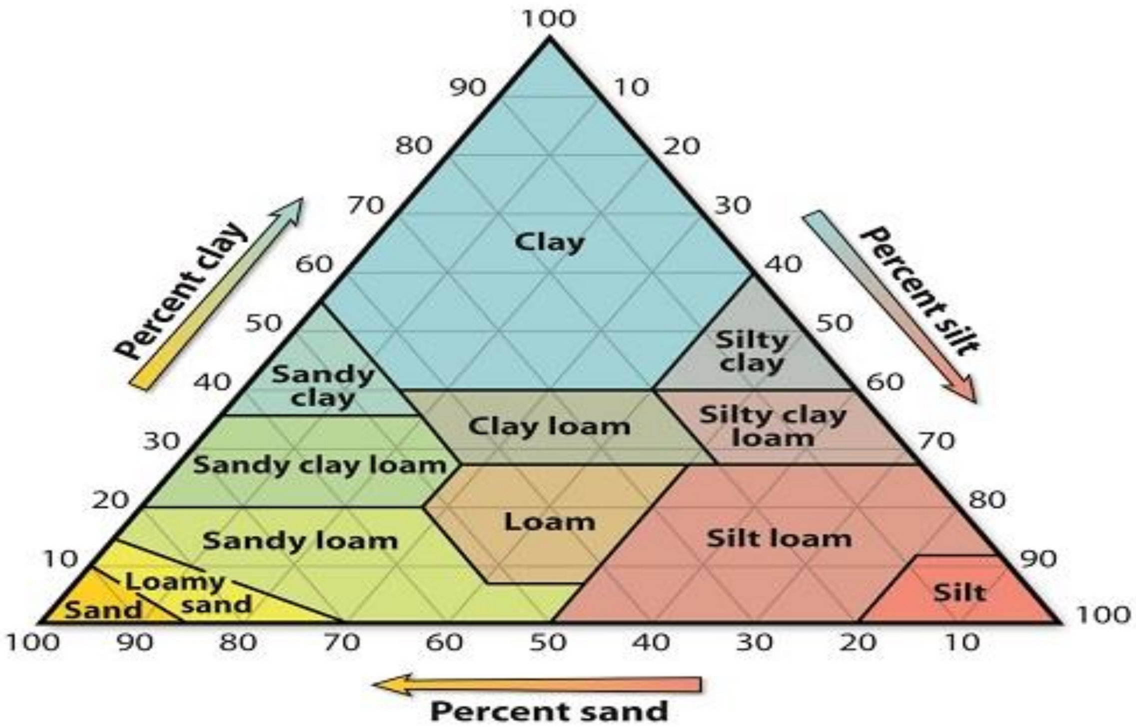
Loam soils are a good mixture of sand, silt, and clay. This soil holds on to most of its nutrients and keeps enough water to help plants get what they need. It also drains enough to avoid waterlogging. Loam soil is generally the best type of soil for growing plants in.

Texture describes the mixture of different particle sizes in soils and names such as sandy loam and clay are used to describe these mixtures. Soils may also be referred to as heavy (clays) and light (coarse textured) to indicate their ease of cultivation. Texture is a fundamental soil property influencing key characteristics such as drainage, water storage, workability, susceptibility to soil erosion and suitability for different uses. It also plays a major part in defining soil 'structure'.

For example, if most particles are large and coarse the soil is called a sand. It looks and feels sandy. A silt soil is dominated by medium-sized particles and feels like flour. Small-sized soil particles primarily make up a clay soil which feels slippery or greasy when wet.

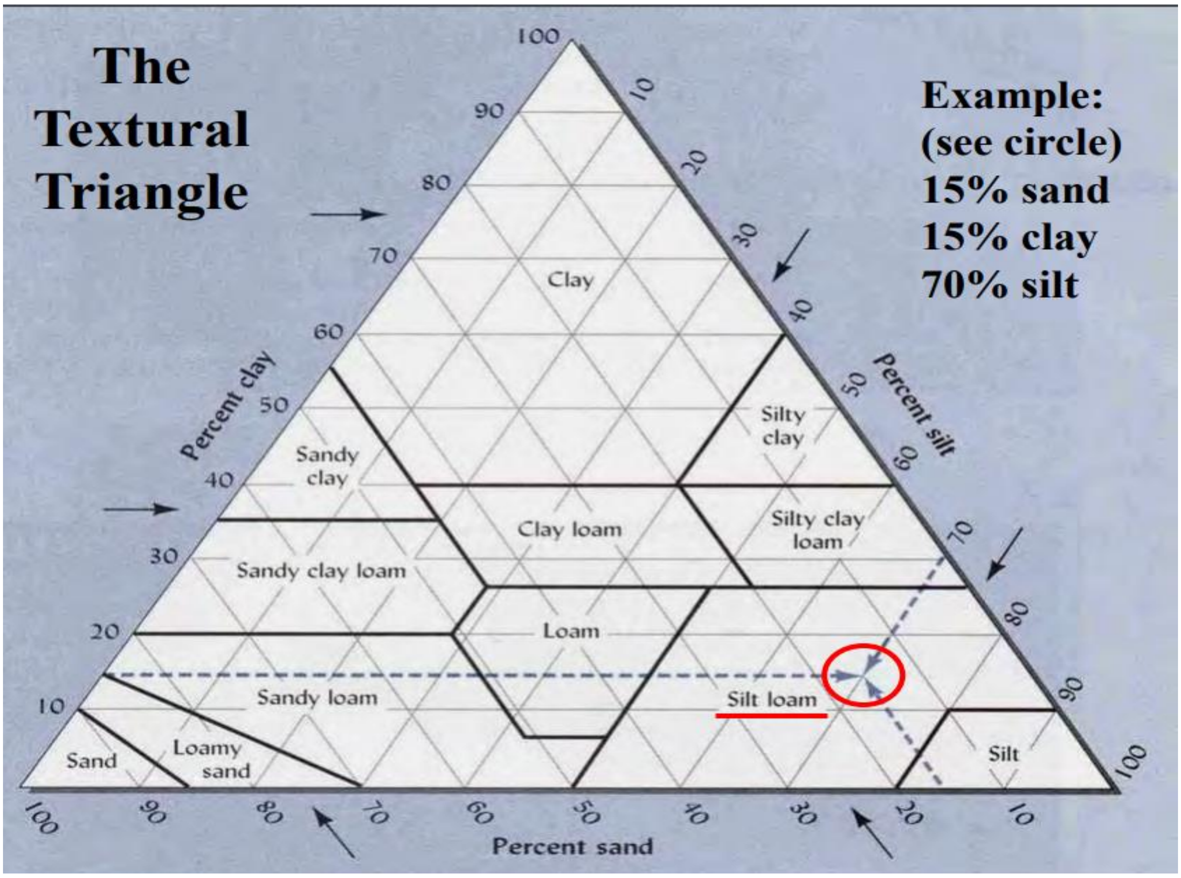
The UK uses a system of classification developed by the former soil survey of England and Wales, which is different from others in use around the world such as the United States Department of Agriculture (USDA). There are 11 major classes, for mineral soils, which are defined by the relative proportions of clay, silt, and sand particles within the soil

There are 12 soil textural classes represented on the soil texture triangle.



This is the textural triangle. If you know the percent clay (flat line) and percent sand or silt, you can draw lines into the triangle to figure out what textural catergory the soil belongs too.

The three sides of the textural triangle represent increasing or decreasing percentages of sand, silt, and clay particles.



Texture is a fundamental soil property influencing key characteristics such as drainage, water storage, workability, susceptibility to soil erosion and suitability for different uses. It also plays a major part in defining **soil 'structure'.**

Soil structure shows about the particles held together as aggregates.

Primary soil particles (sands, silts, clays) become cemented together by organic matter and/or electrostatic forces over time. These groupings are called aggregates or peds. The strength and shape of the peds greatly influence pore size distributions, water holding, gas exchange, and rooting.

Soil structure is defined by the way individual particles of sand, silt, and clay are assembled. Single particles when assembled appear as larger particles. These are called aggregates.

Distinguish between Soil texture and Soil structure:

Soil texture	**Soil structure**
Soil texture refers to the relative proportion of sand, silt, and clay.	Soil structure refers to the arrangement of sand, silt, and clay into a definite pattern.
Examples – Loam, Sandy, Clay, etc.	Examples – Strong Coarse, Angular Blocky.
It is a basic property of soil and cannot be altered easily.	It is easily liable to change under different management practices such as ploughing, liming manuring, etc.
It can be identified by the finger feel method.	It can be identified by its physical appearance.
Soil texture is formed due to weathering.	Soil structure is formed due to physical, chemical, and biological activities.
Based on soil texture soils have been grouped into 12 textural classes.	Based on soil structure soils have been grouped into 5 structural classes.
Loam and silt loam textures are good for agriculture.	Granular and crumby structures are good for agriculture.

https://www.ctahr.hawaii.edu/mauisoil/a_comp01.aspx

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