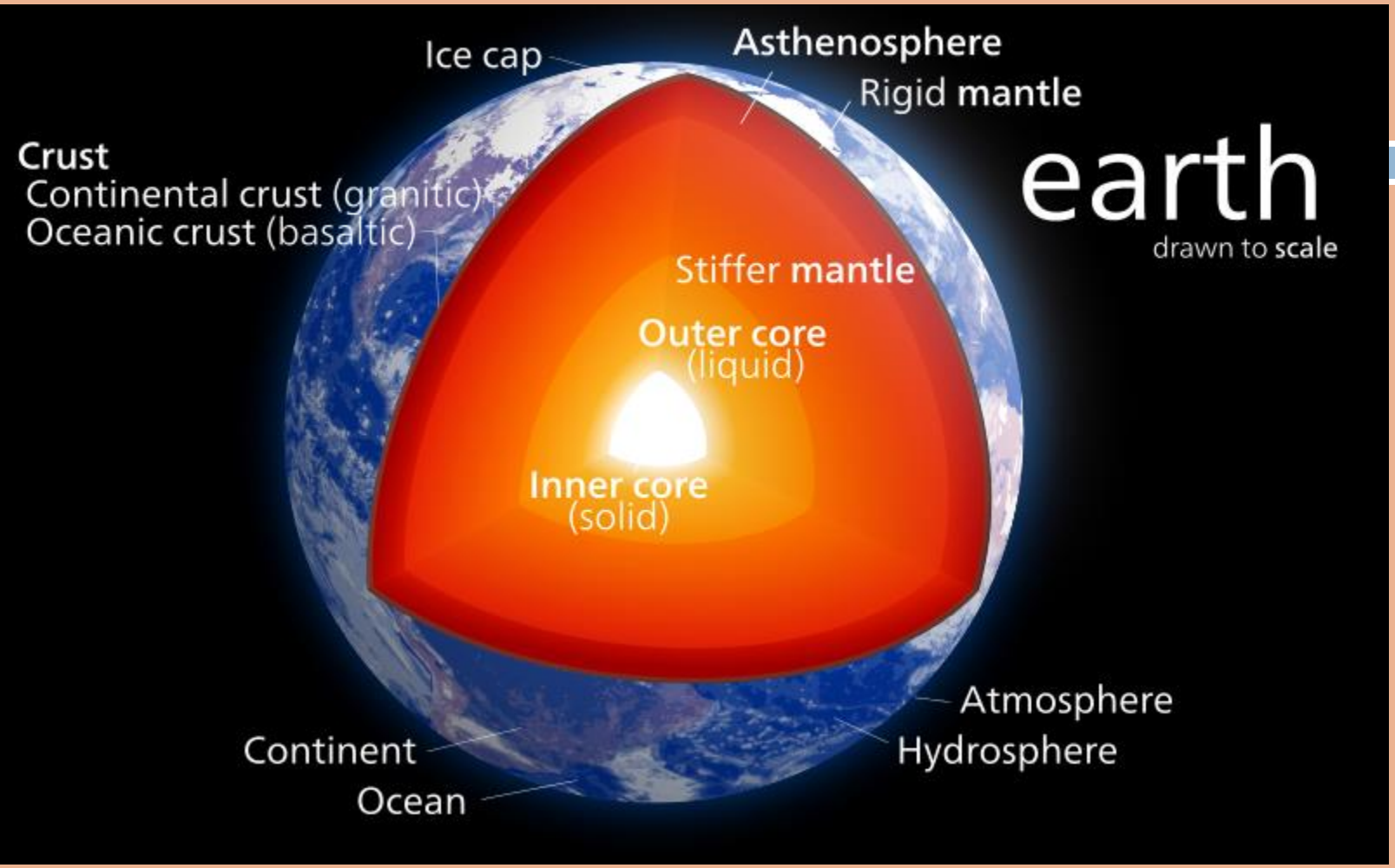
LITHOSPHERE & STRUCTURE OF EARTH


Ice cap
Asthenosphere
Rigid mantle
Crust
Continental crust (granitic)
Oceanic crust (basaltic)
earth
drawn to scale
Stiffer mantle
Outer core
(liquid)
Inner core
(solid)
Atmosphere
Hydrosphere
Continent
Ocean

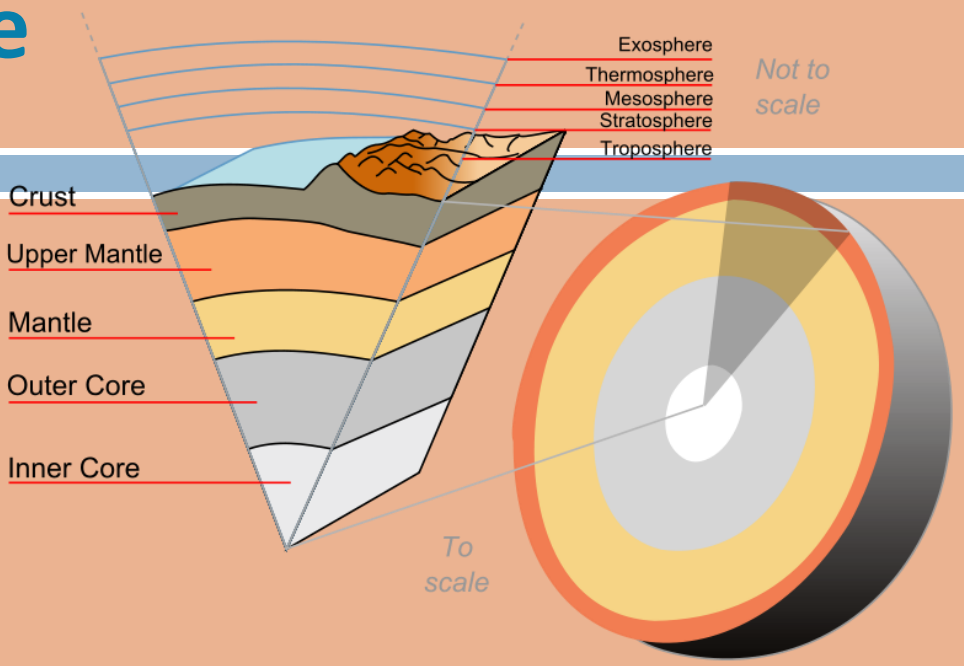
The Composition and Structure of Earth

- Core, mantle, and crust are divisions based on composition.
- The crust makes up less than 1 percent of Earth by mass, consisting of oceanic crust and continental crust is often more felsic rock.
- The mantle is hot and represents about 68 percent of Earth's mass. Finally, the core is mostly iron metal.
- The core makes up about 31% of the Earth.
- Lithosphere and asthenosphere are divisions based on mechanical properties.
- The **lithosphere** is composed of both the crust and the portion of the upper mantle that behaves as a brittle, rigid solid.
- The **asthenosphere** is partially molten upper mantle

material that behaves plastically and can flow.

Crust and Lithosphere

- ✓ Earth's outer surface is its crust; a cold, thin, brittle outer shell made of rock.
- ✓ The crust is very thin, relative to the radius of the planet.
- ✓ There are two very different types of crust, each with its own distinctive physical and chemical properties.



- ✓ **Oceanic crust** is composed of magma that erupts on the seafloor to create basalt lava flows or cools deeper down to create the intrusive igneous rock gabbro.
- ✓ Sediments, primarily muds and the shells of tiny sea creatures, coat the seafloor.
- ✓ Sediment is thickest near the shore where it comes off the continents in rivers and on wind currents.
- ✓ **Continental crust** is made up of many different types of igneous, metamorphic, and sedimentary rocks.
- ✓ The average composition is granite, which is much less dense than the mafic igneous rocks of the oceanic crust.

- ✓ Because it is thick and has relatively low density, continental crust rises higher on the mantle than oceanic crust, which sinks into the mantle to form basins.
- ✓ When filled with water, these basins form the planet's oceans.
- ✓ The lithosphere is the outermost mechanical layer, which behaves as a brittle, rigid solid.
- ✓ The lithosphere is about 100 kilometers thick.
- ✓ The definition of the lithosphere is based on how earth materials behave, so it includes the crust and the uppermost mantle, which are both brittle.
- ✓ Since it is rigid and brittle, when stresses act on the lithosphere, it breaks. This is what we experience as an earthquake.

- ✓ Mantle -
- ✓ The two most important things about the mantle are: (1) it is made of solid rock, and (2) it is hot.
- ✓ The mantle is hot mostly because of heat conducted from the core.
- ✓ Convection is the process of a material that can move and flow may develop convection currents.
- ✓ Convection in the mantle is the same as convection in a pot of water on a stove.
- ✓ Convection currents within Earth's mantle form as material near the core heats up.
- ✓ As the core heats the bottom layer of mantle material, particles move more rapidly, decreasing its density and causing it to rise.

Core

- ✓ At the planet's center lies a dense metallic core.
- ✓ Calculations indicate that the core is about 85 percent iron metal with nickel metal making up much of the remaining 15 percent.
- ✓ If Earth's core were not metal, the planet would not have a magnetic field.
- ✓ Metals such as iron are magnetic, but rock, which makes up the mantle and crust, is not. The strong magnetic field is caused by convection in the liquid outer core.
- ✓ Convection currents in the outer core are due to heat from the even hotter inner core.
- ✓ The heat that keeps the outer core from solidifying is produced by the breakdown of radioactive elements in the inner core.

Lithospheric Plates

A lithospheric plate, or more commonly known as a tectonic plate, is a giant and irregular slab of solid rock that usually comprises both the oceanic well as the continental lithosphere. The size of these tectonic plates varies quite a lot.

How do these plates move?

The radioactive processes that take place within the Earth's interior surface generate a monumental amount of heat which causes the tectonic plates to move away from or towards each other.
This movement of the tectonic plates is referred to as tectonic shift. It is also sometimes called the plate motion.

- ✓ Importance –

- ✓ The lithosphere is important for life to exist. Earth's biosphere relies greatly on the presence of this rocky terrain. Tectonic plates forming lithosphere causes change, which, in turn, gave rise to life as we know it today.

- ✓ The shifting of tectonic plates causes the formation of mountains, volcanoes and even the continents.

- ✓ Volcanoes and earthquakes are devastating in the short term, but give rise to fertile soil and lands in the long term. These lands help in the growth of new vegetation and life.

- ✓ Biotic remains buried in this lithosphere undergo gradual change over millions of years. These organic compounds turn into coal, natural gas and oil, powering modern equipment.

- ✓ The lithosphere is the source for useful minerals and elements, such as iron, aluminum, copper, calcium, magnesium and more. Human beings have used these materials to construct and build machinery and tools.

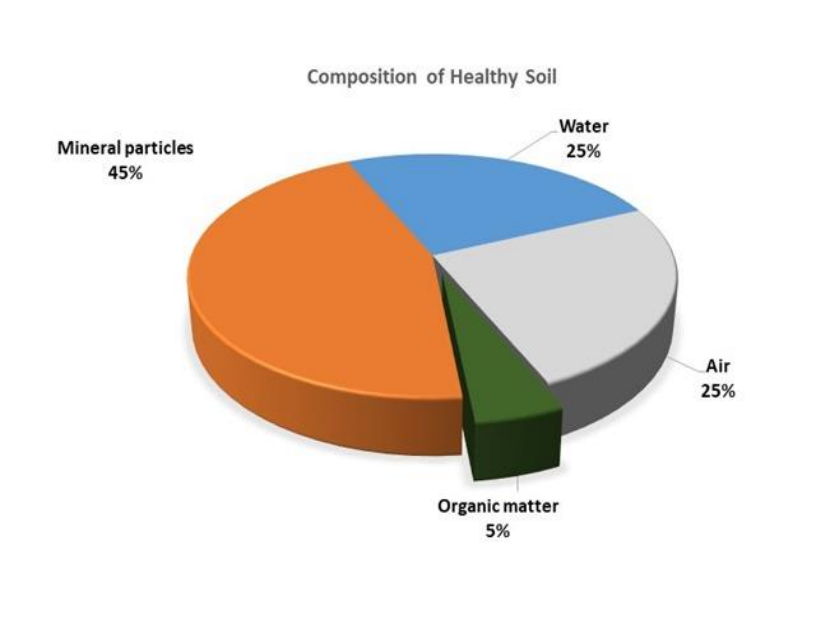
- ✓ Lastly, the lithosphere, along with the hydrosphere and atmosphere, is responsible for providing nutrients to animal life on Earth. The layer offers nutrients to plants, which convert the same into

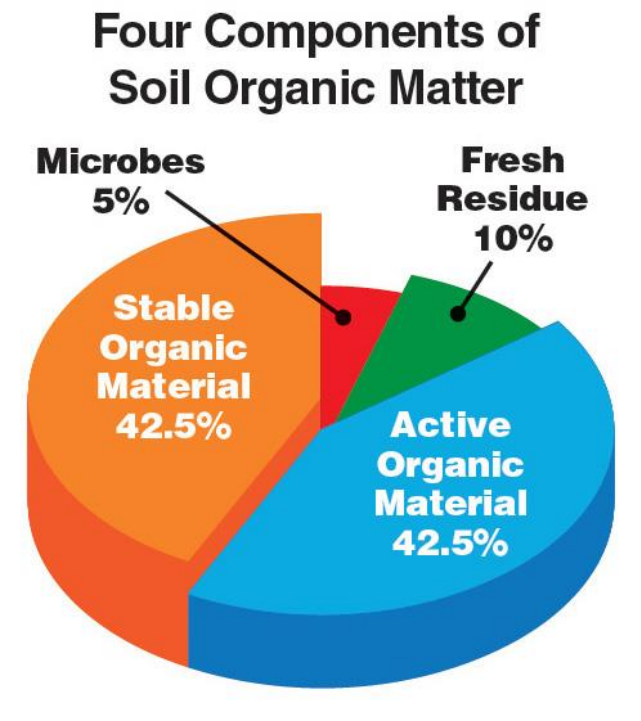
  glucose. This glucose is derived by higher

  animals to survive.

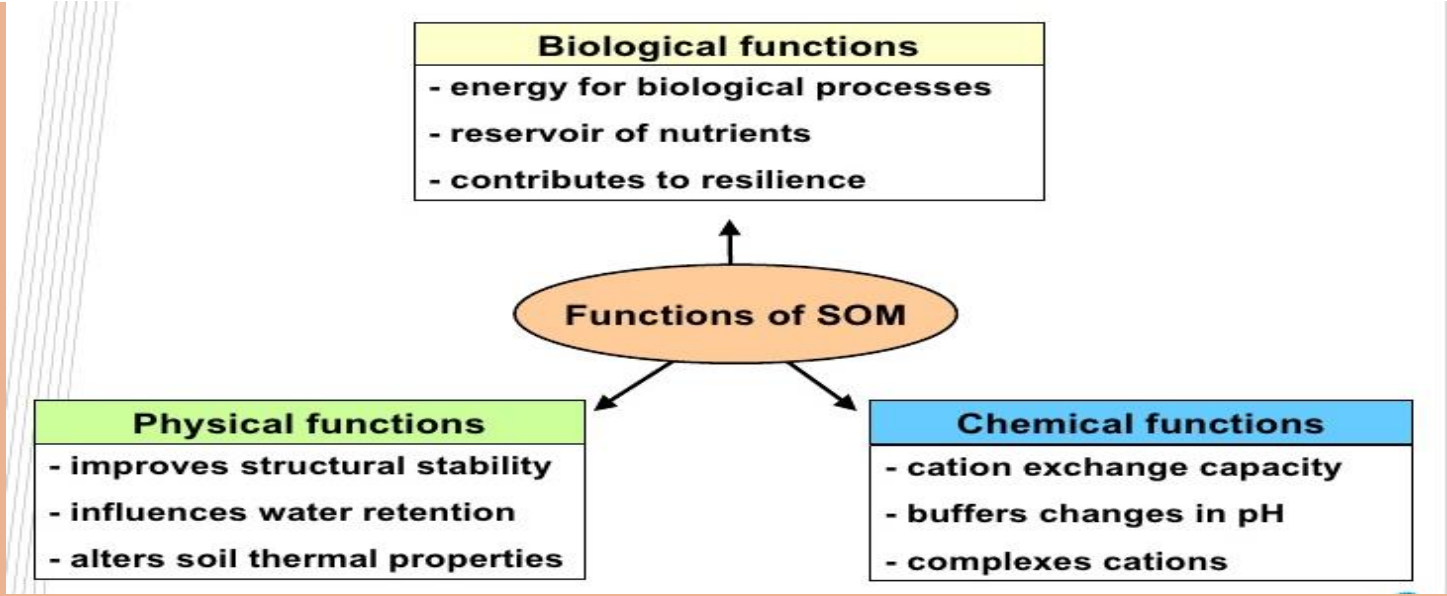
What is soil?

- **Soil** is complex mixtures of minerals, water, air, organic matter, and countless organisms that are the decaying remains of once-living things. It forms at the surface of land – it is the "skin of the earth."
- **Soil** is capable of supporting plant life and is vital to life on earth.

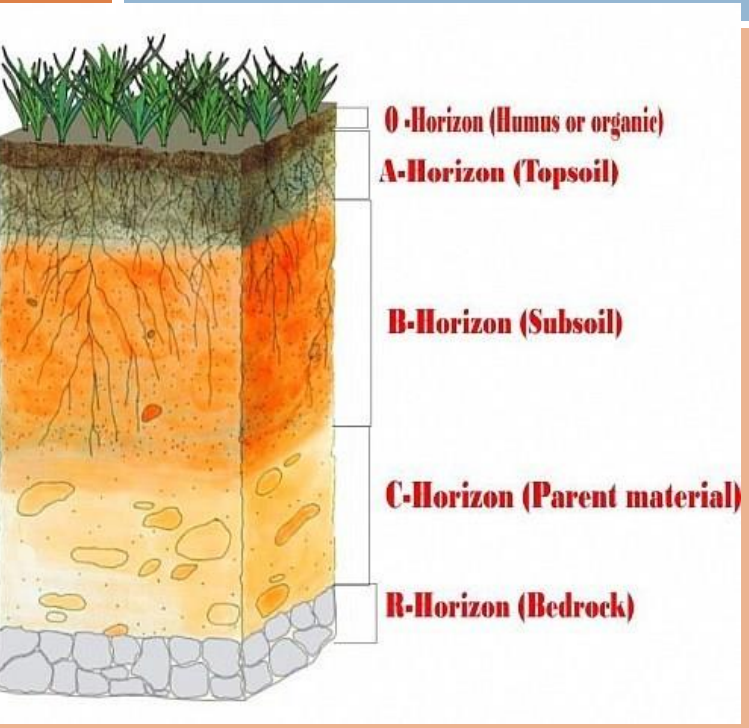

Composition of Healthy Soil
Mineral particles
45%
Water
25%
Air
25%
Organic matter
5%


Four Components of
Soil Organic Matter
Microbes
5%
Fresh
Residue
10%
Stable
Organic
Material
42.5%
Active
Organic
Material
42.5%

Functions of organic matter



Soil Profile



- A **soil profile** is a vertical section of **soil** like the diagram above.
- It allows you to examine the structure of **soil.**
- A **soil profile** is divided into layers called horizons.
- The A horizon is where there is most **soil** life and is sometimes called topsoil.
- Then comes B, C and R Horizons.

- The **soil profile** is an **important** tool in nutrient management.
- By examining a **soil profile**, we can gain valuable insight into **soil** fertility.
- As the **soil** weathers and/or organic matter decomposes, the **profile** of the **soil** changes.
- Now we will view the **soil** as a vital part of the earth's physical landscape.
- Each layer of soil has distinct characteristics.
- Soil profile helps in determining the role of the soil as well, it helps one to differentiate the given sample of soil from other

  soil samples based on factors like its colour,

  texture, structure, and thickness, as well as its

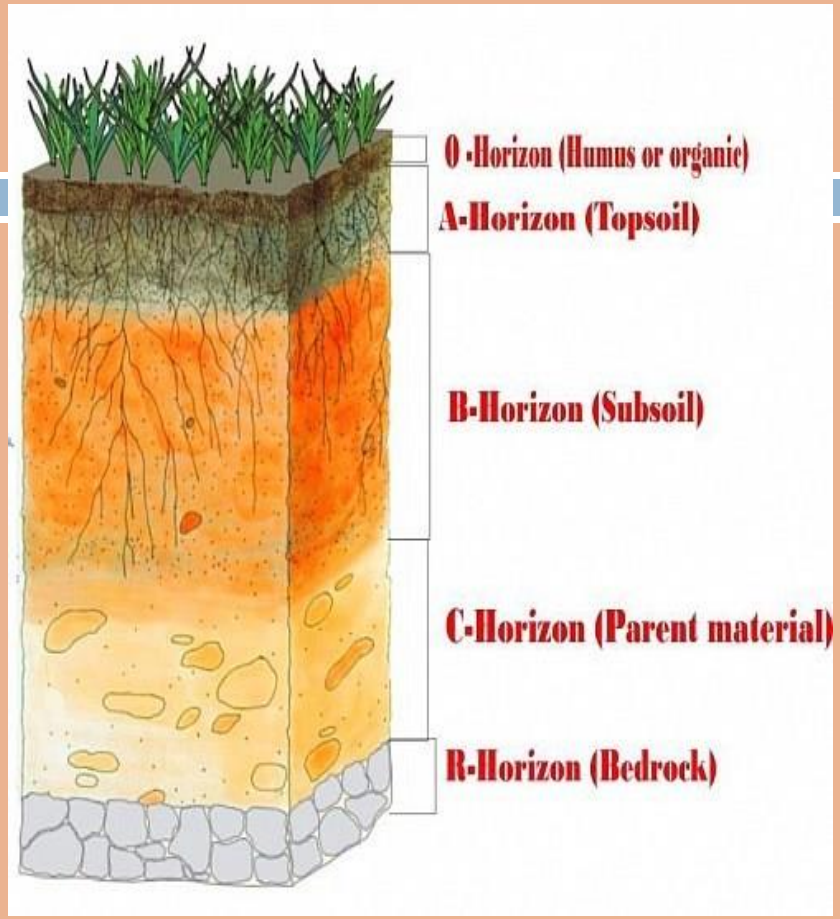
  chemical composition.

Layers of Soil

The soil profile is composed of a series of horizons or layers of soil stacked one on top of the other. These layers or horizons are represented by letters O, A, E, B, C and R.

- The O-Horizon
- The O horizon is the upper layer of the topsoil which is mainly composed of organic materials such as dried leaves, grasses, dead leaves, small rocks, twigs, surface organisms, fallen trees, and other decomposed organic matter. This horizon of soil is often black brown or dark brown in colour and this is mainly because of the presence of organic content.

- The A-Horizon or Topsoil
- This layer is rich in organic material and is known as the humus layer. This layer consists of both organic matter and other decomposed materials.
- The topsoil is soft and porous to hold enough air and water.
- In this layer, the seed germination takes place and new roots are produced which grows into a new plant.
- This layer consists of microorganisms such as earthworms, fungi, bacteria, etc.
- This layer also helps in Nitrogen fixation.



The E-Horizon

- This layer is composed of nutrients leached from the O and A horizons. This layer is more common in forested areas and has lower clay content.
- In well-drained profiles under forest cover, the leached layers (E horizon) may be relatively thick and surface erosion minimal.

The B-Horizon or Subsoil

- It is the subsurface horizon, present just below the topsoil and above the bedrock. It is comparatively harder and compact than topsoil. It contains less humus, soluble minerals, and organic matter. It is a site of

deposition of certain minerals and

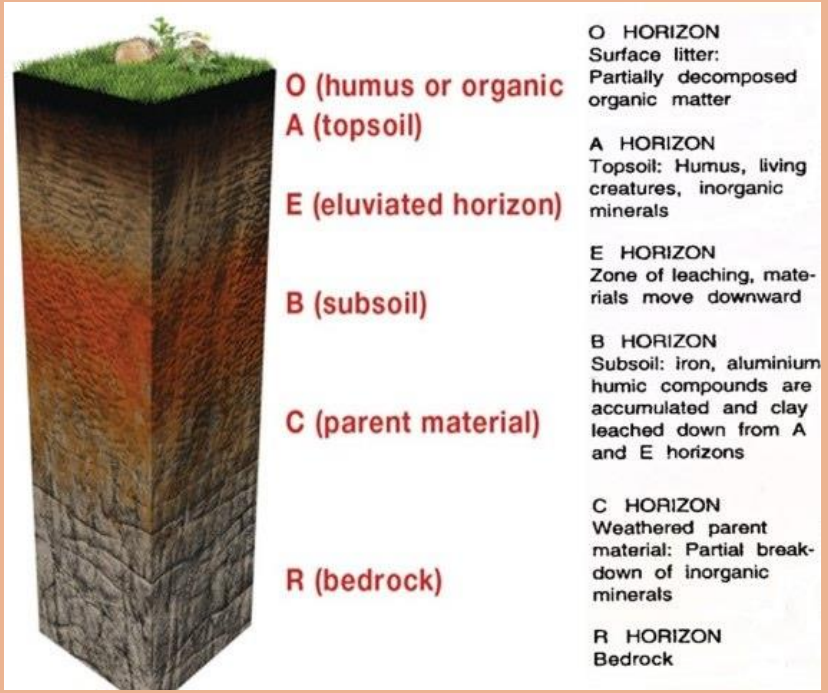
metal salts such as iron oxide.

- This layer holds enough water than the

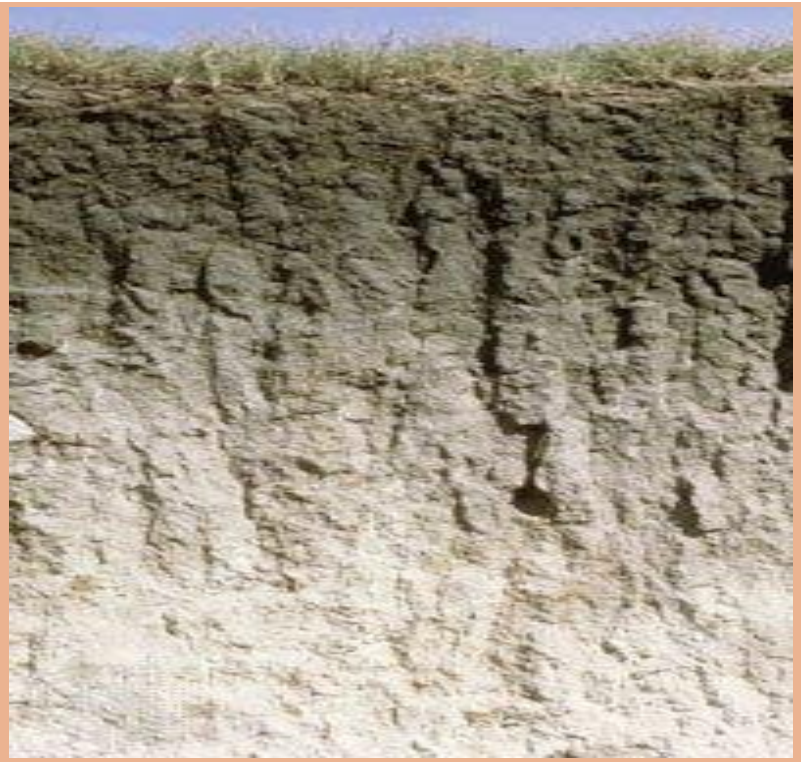
topsoil and is lighter brown due to the presence

of clay soil.

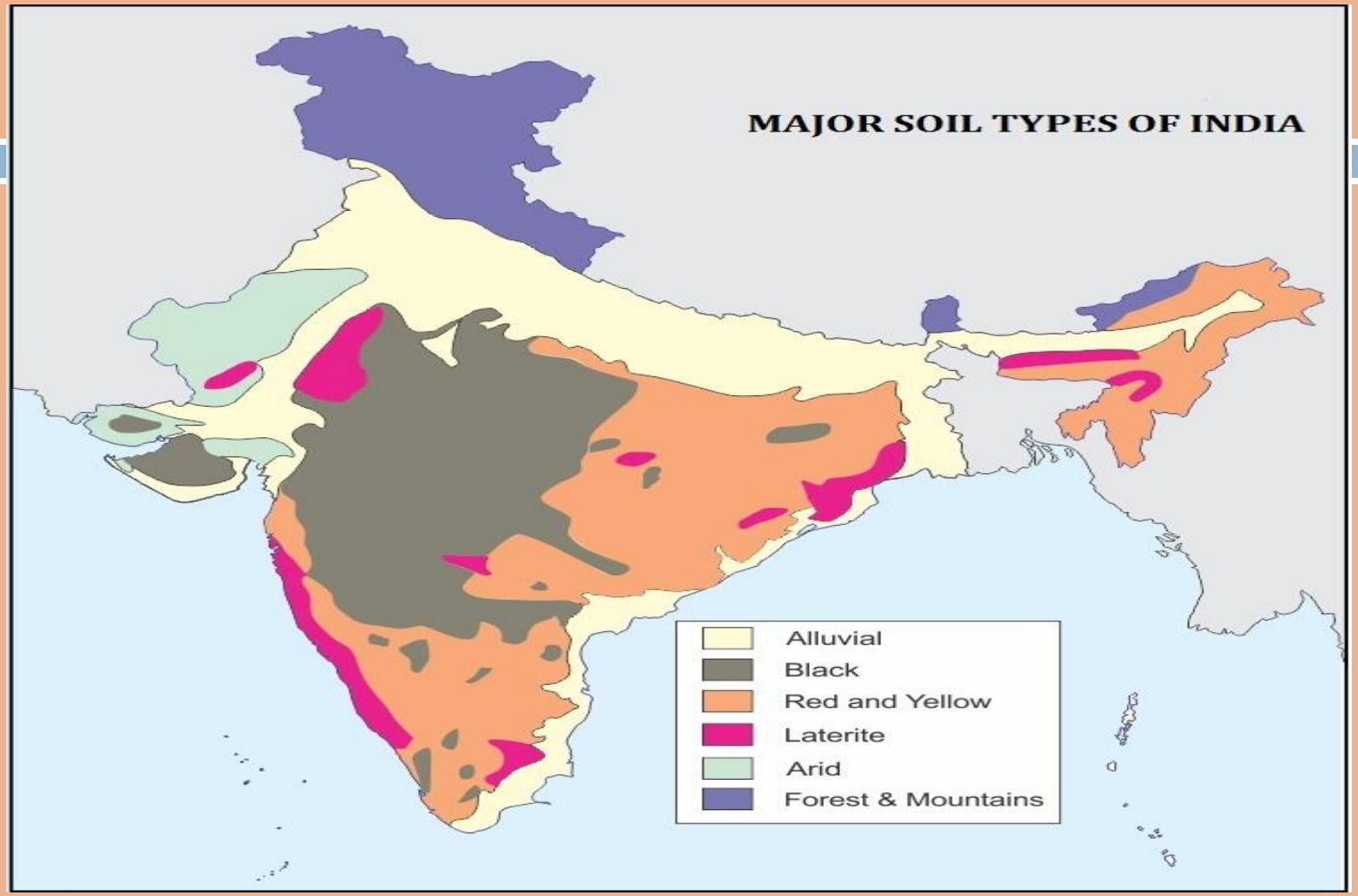
- The C-Horizon or Saprolite
- This layer is devoid of any organic matter and is made up of broken bedrock. This layer is also known as saprolite.
- The geological material present in this zone is cemented.
- The R-Horizon
- It is a compacted and cemented layer. Different types of rocks such as granite, basalt and limestone are found here.



Ferralsol (red) & Mollisol (humus)



Fluvisol (sediment) & Andosol (volcanic eruption)


MAJOR SOIL TYPES OF INDIA
Alluvial
Black
Red and Yellow
Laterite
Arid
Forest & Mountains

Soil Pollution

- Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse affects on plant growth and animal health.
- Soil is the thin layer of organic and inorganic materials that covers the Earth's rocky surface. The organic portion, which is derived from the decayed remains of plants and animal, is concentrated in the dark uppermost topsoil.
- The inorganic portion made up of rock fragments, was formed over thousands of years by physical and chemical

  weathering of bedrock. Productive soils are

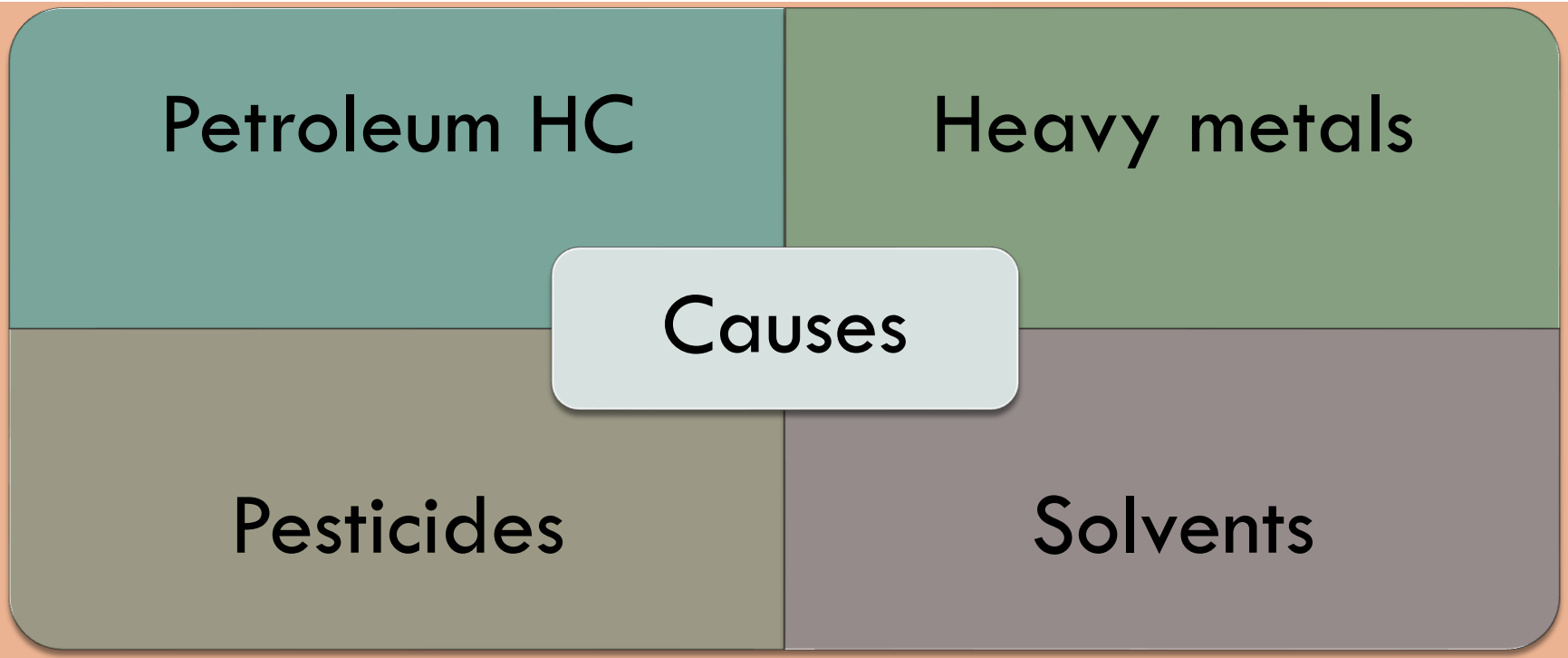
  necessary for agriculture to supply the world

  with sufficient food.

General Causes

- There are many different ways that soil can become polluted, such as:
- Seepage from a landfill
- Discharge of industrial waste into the soil
- Percolation of contaminated water into the soil
- Rupture of underground storage tanks
- Excess application of pesticides, herbicides or fertilizer
- Solid waste seepage

Some common causes



Inorganic Toxic compounds

- Inorganic residues in industrial waste cause serious problems as regards their disposal.
- They contain metals which have high potential for toxicity. Industrial activity also emits large amounts of arsenic fluorides and sulphur dioxide (SO_2).
- Fluorides are found in the atmosphere from superphosphate, phosphoric acid, aluminium, steel and ceramic industries.
- Sulphur dioxide emitted by factories and thermal plants may make soils very acidic. These metals cause leaf injury and destroy

  vegetation.

- Copper, mercury, cadmium, lead, nickel, arsenic are the elements which can accumulate in the soil, if they get entry either through sewage, industrial waste or mine washings.
- Some of the fungicides containing copper and mercury also add to soil pollution. Smokes from automobiles contain lead
- which gets adsorbed by soil particles and is toxic to plants. The toxicity can be minimized by building up soil organic matter, adding lime to soils and keeping

  the soil alkaline.

Organic Waste

- Organic wastes of various types cause pollution hazards.
- Domestic garbage, municipal sewage and industrial wastes when left in heaps or improperly disposed seriously affect health of human beings, plants and animals.
- Organic wastes contain borates, phosphates, deter- gents in large amounts.
- If untreated they will affect the vegetative

  growth of plants. The main organic

  contaminants are phenols and coal.

- Asbestos, combustible materials, gases like methane, carbon dioxide, hydrogen sulphide, carbon monoxide, sulphur dioxide, petrol are also contaminants.
- The radioactive materials like uranium, thorium, strontium etc. also cause dangerous soil pollution.
- Fallout of strontium mostly remains on the soil and is concentrated in the sediments.
- Decontamination procedures may include continuous cropping and use of chelate amendments.
- Other liquids wastes like sewage,

sewage sludge, etc. are also important

sources of soil problems.

Sewage Sludge

- Soil pollution is often caused by the uncontrolled disposal of sewage and other liquid wastes resulting from domestic uses of water, industrial wastes containing a variety of pollutants, agricultural effluents from animal husbandry and drainage of irrigation water and urban runoff.
- Irrigation with sewage water causes profound changes in the irrigated soils. Amongst various changes that are brought about in the soil as an outlet of sewage irrigation include physical changes like leaching, changes in humus content, and porosity etc.,
- chemical changes like soil reaction, base exchange status, salinity, quantity and availability of nutrients like nitrogen, potash, phosphorus,

etc. Sewage sludges pollute the soil by accumulating

the metals like lead, nickel, zinc, cadmium, etc.

This may lead to the phytotoxicity of plants.

Heavy Metal Toxicity

- Heavy metals are elements having a density greater than five in their elemental form.
- They mostly find specific absorption sites in the soil where they are retained very strongly either on the inorganic or organic colloids.
- They are widely distributed in the environment, soils, plants, animals and in their tissues. These are essential for plants and animals in trace amounts.
- Mainly urban and industrial aerosols, combustion of fuels, liquid and solid from animals and human beings, mining wastes, industrial and agricultural chemicals etc. are contributing heavy

  metal pollution.

- In agricultural soils, however, the concentration of one or more of these elements may be significantly increased in several ways, like through applications of chemicals, sewage sludge, farm slurries, etc.
- Increased doses of fertilizers, pesticides or agricultural chemicals, over a period, add heavy metals to soils which may contaminate them.
- Certain phosphoric fertilizers frequently contain trace amounts of cadmium which may accumulate

  in these soils.

Organic Pesticides

- Pesticides are quite frequently used to -control several types of pests now-a-days.
- Pesticides may exert harmful effects to micro-organisms, as a result of which plant growth may be affected.
- Pesticides which are not rapidly decomposed may create such problems.
- Accumulation is residues of pesticides in higher concentrations are toxic.
- Pesticides persistence in soil and movement into water streams may also lead to their entry into foods and create health hazards.
- Pesticides particularly aromatic organic compounds are not degraded rapidly and therefore, have a long persistence time.
- Mercury, cadmium and arsenic are common

constituents of pesticides and all these heavy metals

are toxic.

Effects on human health

- Considering how soil is the reason we are able to sustain ourselves, the contamination of it has major consequences on our health. Crops and plants that are grown on polluted soil absorb much of the pollution and then pass these on to us. This could explain the sudden surge in small and terminal illnesses.
- Long term exposure to such soil can affect the genetic make-up of the body, causing congenital illnesses and chronic health problems that cannot be cured easily. In fact, it can sicken the livestock to a considerable extent and cause food poisoning over a long period of time. The soil pollution can even lead to widespread famines if the plants are

  unable to grow in it.

Effect on growth of plants

The ecological balance of any system gets affected due to the widespread contamination of the soil. Most plants are unable to adapt when the chemistry of the soil changes so radically in a short period of time. Fungi and bacteria found in the soil that bind it together begin to decline, which creates an additional

problem of soil erosion.

Decreased soil Fertility

The toxic chemicals present in the soil can decrease soil fertility and therefore decrease in the soil yield. The contaminated soil is then used to produce fruits and vegetables, which lacks quality nutrients and may contain some poisonous substance to

cause serious health problems

in people consuming them.

Poisoning of underground water

- Soil pollution also leads to the poisoning of the underground water table. Since this water is stored beneath the layers of the soil, the toxins in the soil could easily percolate slowly and steadily into the water.
- We must also remember that this is the water that is available for consumption and usage through wells and tube wells. When such toxic water is consumed or used over a period of time, it causes a lot of ill effects on our health.
- Diseases like arsenic poisoning, food poisoning and others are caused due to the prolonged consumption of this toxic

  underground water.

Possible solution to the problem

- Reduced use of chemical fertilizers
- Reforestation & Forestation should be promoted
- Recycle & reuse the products
- Use of natural manure should be promoted

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