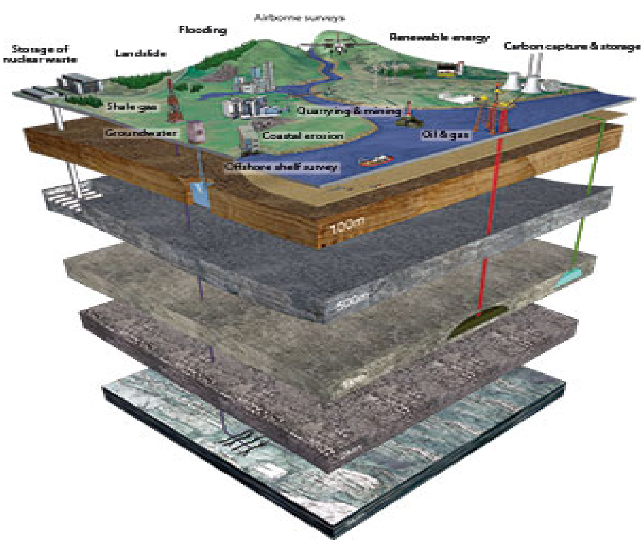
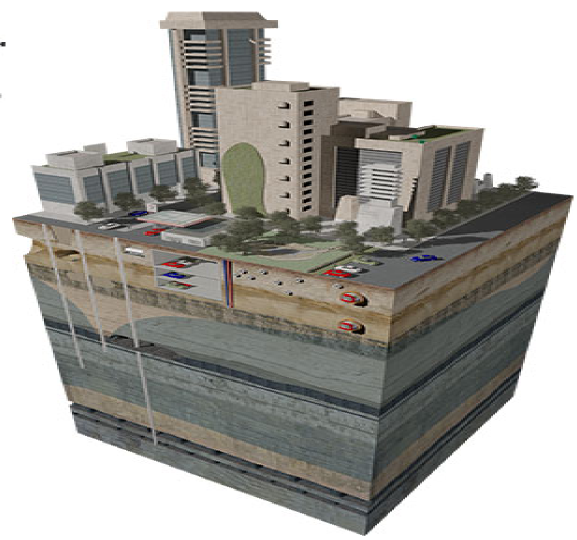
The Study of Geo Science from Local, National & Global Point of View

Vamsi Velagaleti S.P.
Assistant Professor, Department of Mechanical Engineering
Sri Indu College of Engineering & Technology, Sheriguda, Ibrahimpatan, R.R Dist. 501 510, Telangana, India

Abstract - Earth sciences**, the fields of study concerned with the solid Earth, its waters, and the air that envelops it. Included are the geologic, hydrologic, and atmospheric sciences. The occurrence of seashells embedded in the hard rocks of high mountains aroused the curiosity of early naturalists and eventually set off a controversy on the origin of fossils that continued through the 17th century. Xenophanes of Colophon (flourished *c.* 560 BCE) was credited by later writers with observing that seashells occur "in the midst of earth and in mountains." He is said to have believed that these relics originated during a catastrophic event that caused the earth to be mixed with the sea and then to settle, burying organisms in the drying mud. For these views Xenophanes is sometimes called the father of paleontology. Petrified wood was described by Chinese scholars as early as the 9th century CE, and about1080 Shen Gua cited fossilized plants as evidence for change in climate. Other kinds of fossils that attracted the attention of early Chinese writers include spiriferoid brachiopods ("stone swallows"), cephalopods, crabs, and the bones and teeth of reptiles, birds, and mammals. Although these objects were commonly collected simply as curiosities or for medicinal purposes, Shen Gua recognized marine invertebrate fossils for what they are and for what they imply historically. Observing seashells in strata of the Taihang Mountains, he concluded that this region, though now far from the sea, must once have been a shore.**

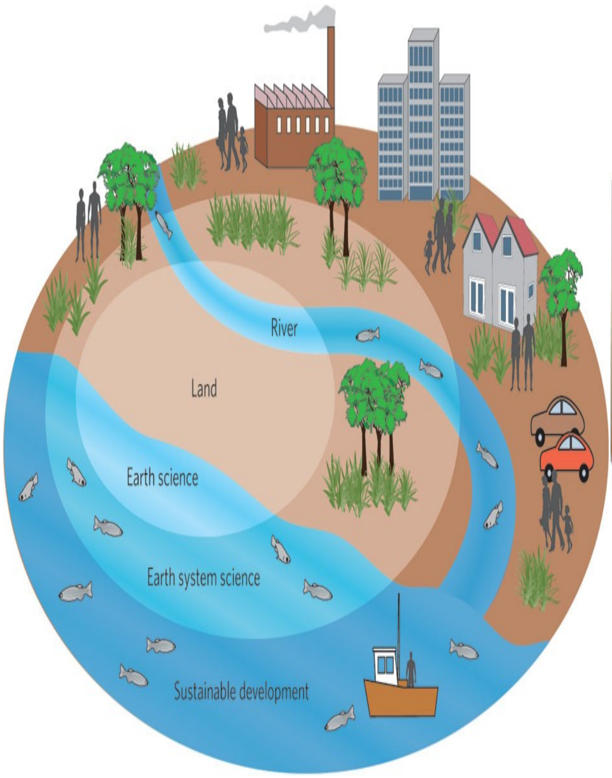


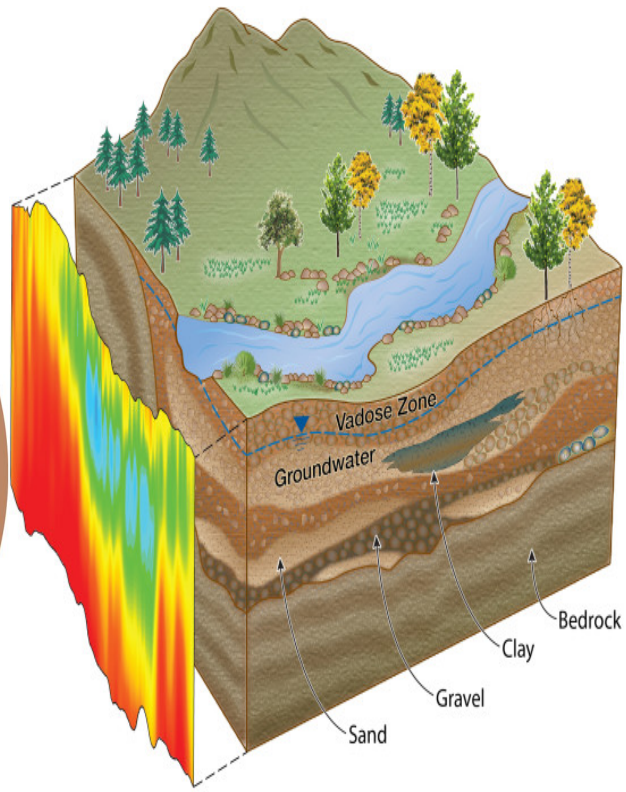


I. GEO SCIENCE

1. "Geology," "Earth science" and "geoscience" are different terms with the same literal definition: The study of the Earth.
2. Geoscience is the scientific study of the planet Earth and its many different natural geologic systems.
3. It includes the study and investigation of Earth's minerals, soil, water and energy resources: its oceans, atmosphere, rivers and lakes, ice sheets and glaciers, soils, its complex surface, rocky interior, and metallic core, how Earth's natural systems work today, how they operated in the recent and ancient past, and how we expect they may behave in the future.
4. Geoscience is real-world science, relevant to us all, everyday.
5. Geoscience (also called Earth Science) is the study of Earth. Geoscience includes so much more than rocks and volcanoes, it studies the processes that form and shape Earth's surface, the natural resources we use, and how water and ecosystems are interconnected.

6. Geoscience uses tools and techniques from other science fields as well, such as chemistry, physics, biology, and math!
7. Our Earth has been around for more than four billion years so there's a lot of information to work with.
8. Some geoscientists work in a traditional broad area of Earth science like geology, geophysics, geochemistry and environmental geoscience.
9. Others practice geoscience in one of many specialized areas, such as volcanology (volcanoes), paleontology (fossils) or geochronology (age-dating rocks); or they work in a new emerging discipline such as medical or forensic geology.





10. What's important to remember is that there are many different types of geoscientists and different forms of geoscience practice.



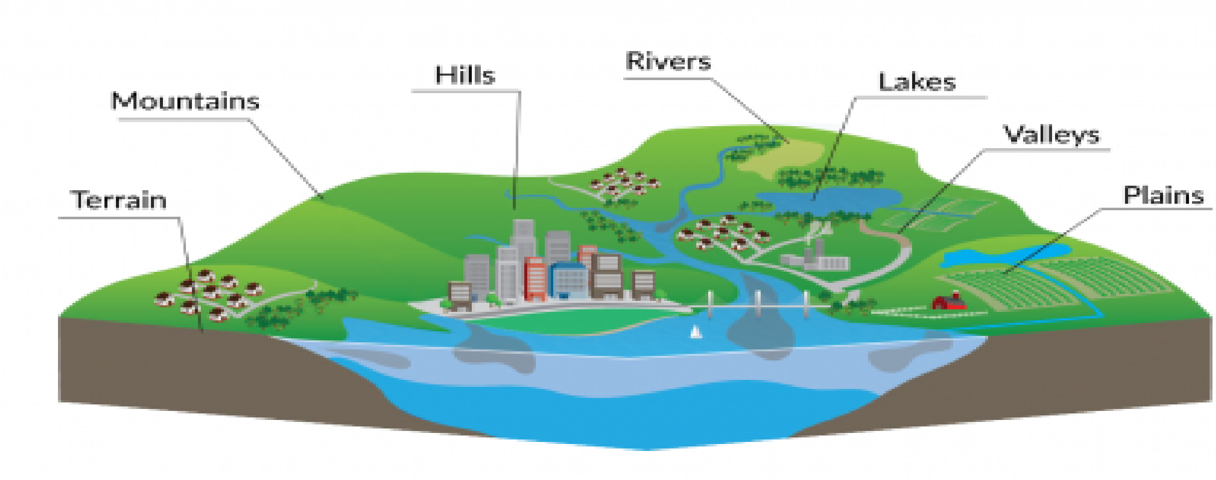
The list of topics in Geo Science include:

1. Topography
2. Volcanoes
3. Earthquakes
4. Rocks & Minerals
5. Soils & Weathering
6. Hydrology
7. Oceanography
8. Atmosphere
9. Weather & Climate
10. Astronomy

II. TOPOGRAPHY

The origin of topography comes from “topo” for “place” and “graphia” for “writing”. Topography is a broad term used to describe the detailed study of the earth's surface. This includes changes in the surface such as mountains and valleys as well as features such as rivers and roads. It can also include the surface of other planets, the moon, asteroids and meteors. Topography is closely linked to the practice of surveying, which is the practice of determining and recording the position of points in relation to one another.

Modern-day topography is generally concerned with the measurement and recording of elevation contours, producing a three-dimensional representation of the earth's surface. A series of points are chosen and measured in terms of their horizontal coordinates, such as latitude and longitude, and their vertical position, in terms of altitude. When recorded in a series, these points produce contour lines which show gradual changes in the terrain. The most widely used form of measurement is known as Direct Survey.



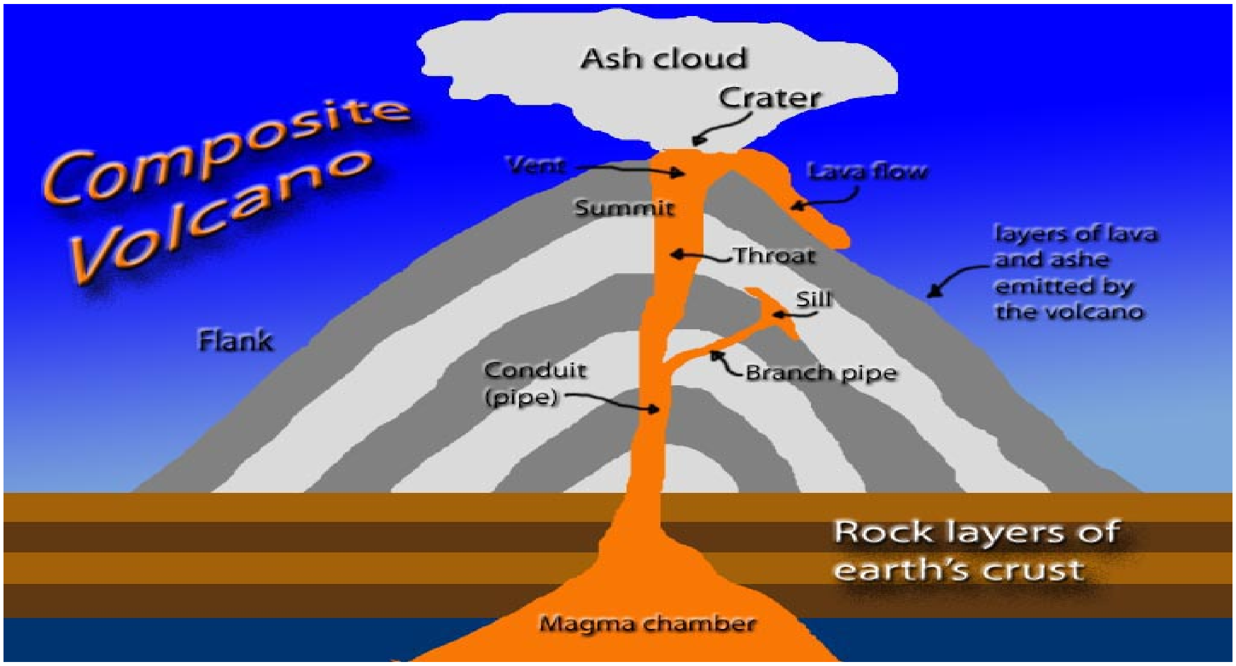
This is the process of manually measuring distances and angles using leveling instruments such as theodolites. Direct surveying provides the basic data for all topographic mapping, including digital imaging systems. This information can be used in conjunction with other systems such as aerial photography or satellite imagery to provide a complete picture of the land in question.

III. VOLCANO

A volcano on Earth is a vent or fissure in the planet's crust through which lava, ash, rock and gases erupt. A volcano is also a mountain formed by the accumulation of these eruptive products.

Volcanoes have existed for a long time on Earth, likely causing disasters such as the Permian mass extinction about 250 million years ago, the greatest mass extinction in Earth's history, Volcanoes can and have existed on other worlds as well: although volcanoes on the moon and Mars have long been dormant, volcanoes are still very active on Jupiter's moon Io.

Earth's crust is 3 to 37 miles (5 to 60 kilometers) thick, according to the U.S. Geological Survey. It is broken up into seven major and 152 smaller pieces called tectonic plates. These plates float on a layer of magma semi-liquid rock and dissolved gases. At the boundaries of these plates where they move past, are pushed under, or move away from each other magma, which is lighter than the surrounding solid rock, is often able to force its way up through cracks and fissures.



Magma can explode from the vent, or it can flow out of the volcano like an overflowing cup. Magma that has erupted is called lava. Types of volcanoes include the following:

1. Cinder cone volcanoes (also called scoria cones) are the most common type of volcano,
2. Stratovolcanoes are also called composite volcanoes because they are built of layers of alternating lava flow, ash and blocks of unmelted stone,
3. Shield volcanoes are huge, gently sloping volcanoes built of very thin lava spreading out in all directions from a central vent.
4. Lava domes are built up when the lava is too viscous to flow. A bubble or plug of cooling rock forms over a fissure.

IV. EARTHQUAKES

Earthquakes are the result of plate tectonics, or shifting plates in the crust of Earth, and quakes occur when the frictional stress of gliding plate boundaries builds and causes failure at a fault line. In an earthquake, elastic strain energy is released and waves radiate, shaking the ground. Scientists can predict where major temblors might occur in a general sense, but research does not yet allow forecasts for specific locations or accurate predictions of timing. Major earthquakes, some generating tsunamis, have leveled entire cities and affected whole countries. Relatively minor earthquakes can also be induced, or caused by human activity, including extraction of minerals from Earth and the collapse of large buildings.

V. ROCKS AND MINERALS

A **rock** is a solid material that is composed of various minerals. Earth's crust is composed of rocks. It's an aggregate of one or more minerals. Rocks do not have definite composition of mineral constituents. However, feldspar and quartz are the most common minerals found in rocks. Petrology is science of rocks. It is a branch of geology. A petrologist studies rocks in all aspects – composition, texture, structure, origin, occurrence, alternation and relationship with other rocks.

Based on their mode of formation, there are three different types of rocks:

1. **Igneous rocks** – solidifies from magma and lava.
2. **Sedimentary rocks** – the result of deposition of fragments of rocks by exogenous processes.
3. **Metamorphic rocks** – formed out of existing rocks undergoing re-crystallization.

Minerals are the building blocks of the earth. A **mineral** is a combination of elements that forms an inorganic, naturally occurring solid of a definite chemical structure. For example, SiO_2 is always the mineral quartz.

Minerals can have a variety of crystalline shapes. The shape of the crystal is dependent on the sizes of the atoms of the elements, the chemical bonds that hold the elements together to form the mineral, and the pressure and temperature at which the mineral formed.

Most minerals are built around **silica tetrahedrons** four oxygen atoms connected to a smaller, central silicon atom. Different arrangements of silica tetrahedrons create distinctive atomic structures in minerals, such as **sheet silicates** (the mica and clay mineral groups), **chain silicates** (the pyroxene mineral group), or **framework silicates** (the quartz and feldspar mineral groups).

VI. SOILS & WEATHERING

Soils are 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.
Soil, as formally defined in the Soil Science Society of America Glossary of Soil Science Terms, is:

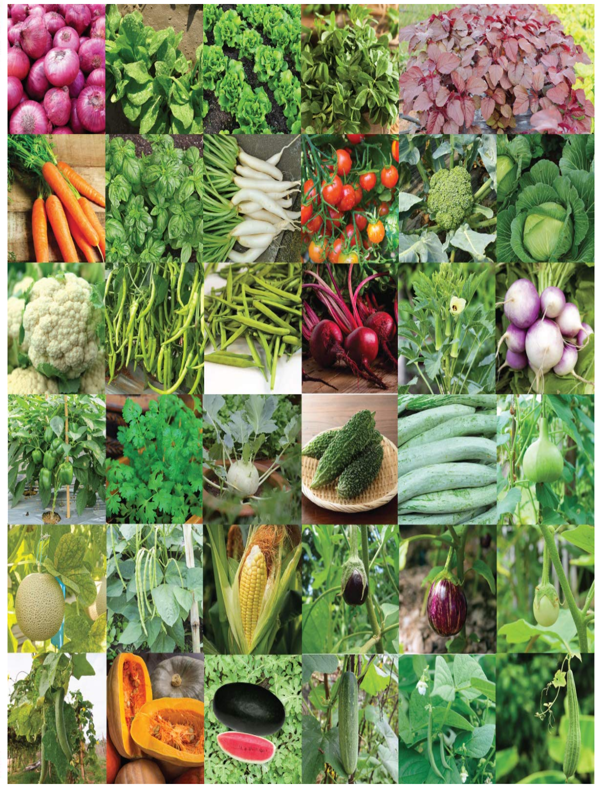
1. The unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.

2. The unconsolidated mineral or organic matter on the surface of the earth that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects), and macro- and microorganisms, conditioned by relief, acting on parent material over a period of time.

Dirt is what gets on our clothes or under our fingernails. It is soil that is out of place in our world, whether tracked inside by shoes or on our clothes. Dirt is also soil that has lost the characteristics that give it the ability to support life.

Soil performs many critical functions in almost any ecosystem (whether a farm, forest, prairie, marsh, or suburban watershed). There are seven general roles that soils play:

1. Soils serve as media for growth of all kinds of plants.
2. Soils modify the atmosphere by emitting and absorbing gases (carbon dioxide, methane, water vapor, and the like) and dust.
3. Soils provide habitat for animals that live in the soil (such as groundhogs and mice) to organisms (such as bacteria and fungi), that account for most of the living things on Earth.
4. Soils absorb, hold, release, alter, and purify most of the water in terrestrial systems.
5. Soils process recycled nutrients, including carbon, so that living things can use them over and over again.
6. Soils serve as engineering media for construction of foundations, roadbeds, dams and buildings, and preserve or destroy artifacts of human endeavors.
7. Soils act as a living filter to clean water before it moves into an aquifer.

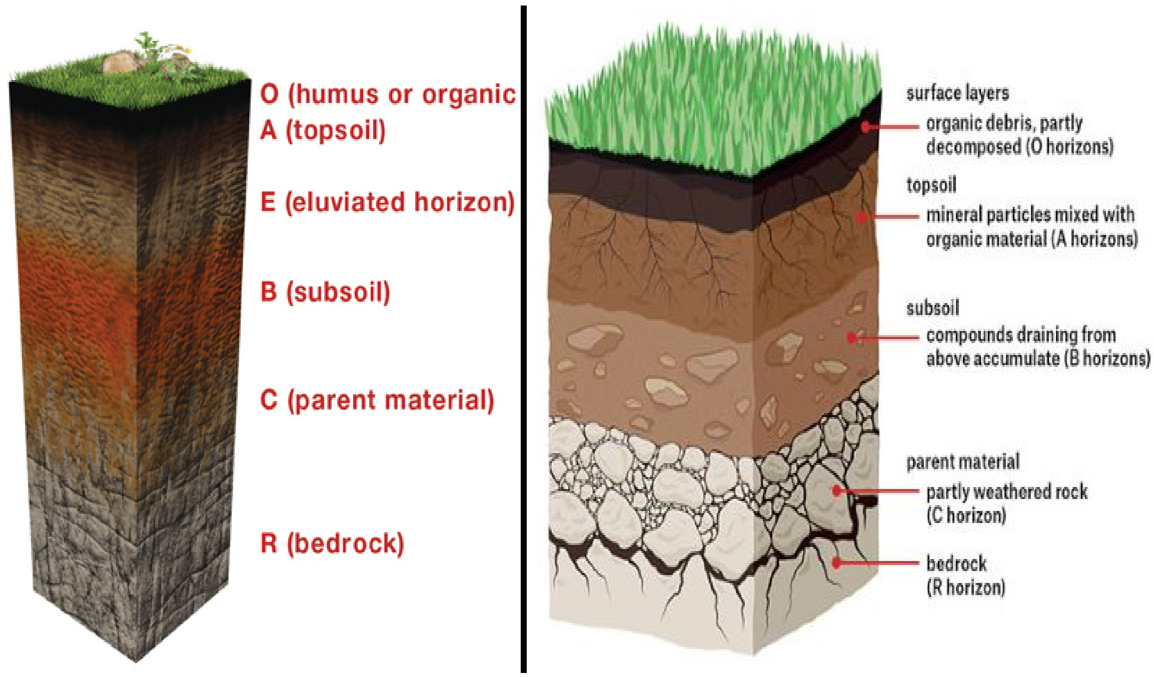


Soil Profile

There are different types of soil, each with its own set of characteristics. Dig down deep into any soil, and you'll see that it is made of layers, or horizons (O, A, E, B, C, R). Put the horizons together, and they form a soil profile. Like a biography, each profile tells a story about the life of a soil. Most soils have three major horizons (A, B, C) and some have an organic horizon (O).

The horizons are:

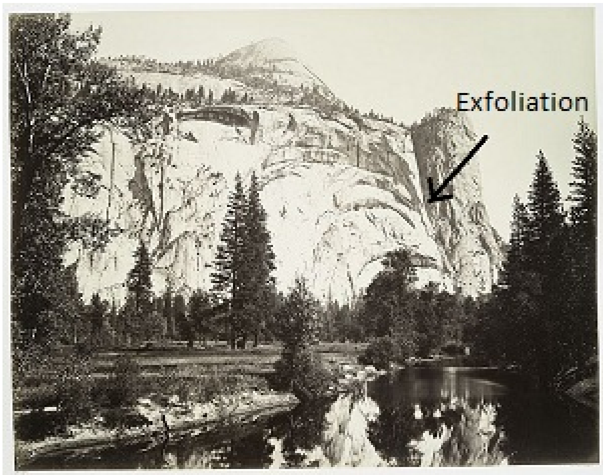
1. O – (humus or organic) Mostly organic matter such as decomposing leaves. The O horizon is thin in some soils, thick in others, and not present at all in others.
2. A - (topsoil) Mostly minerals from parent material with organic matter incorporated. A good material for plants and other organisms to live.
3. E – (eluviated) Leached of clay, minerals, and organic matter, leaving a concentration of sand and silt particles of quartz or other resistant materials – missing in some soils but often found in older soils and forest soils.
4. B – (subsoil) Rich in minerals that leached (moved down) from the A or E horizons and accumulated here.
5. C – (parent material) The deposit at Earth's surface from which the soil developed.
6. R – (bedrock) A mass of rock such as granite, basalt, quartzite, limestone or sandstone that forms the parent material for some soils – if the bedrock is close enough to the surface to weather. This is not soil and is located under the C horizon.



Weathering is breaking down rocks, soil, and minerals as well as wood and artificial materials by contacting the atmosphere, water, and biological organisms of the Earth. Weathering takes place in situ, i.e. in the same place, with little or no movement. It should therefore not be confused with erosion involving the movement of rocks and minerals by agents such as water, ice, snow, wind, waves and gravity, and then transported and deposited elsewhere. There are two types of weathering – Physical Weathering, Chemical Weathering.

Physical Weathering: Physical weathering is the breaking of rocks into smaller pieces. This can happen through exfoliation, freeze-thaw cycles, abrasion, root expansion, and wet-dry cycles.

1. ***Exfoliation-*** when temperature of rocks rapidly changes that can expand or crack rocks. This especially happens with granitic rocks as they were cooling, like at Yosemite National Park.
2. ***Freeze-thaw*** - when water freezes, it expands. If moisture seeps into cracks before winter, it can then freeze, driving the rocks apart.
3. ***Abrasion*** - when the wind blows, it can pick up sand and silt, and literally sandblast rocks into pieces.
4. ***Root expansion*** - like freeze thaw, roots grow bigger every year. These roots can drive the roots apart.

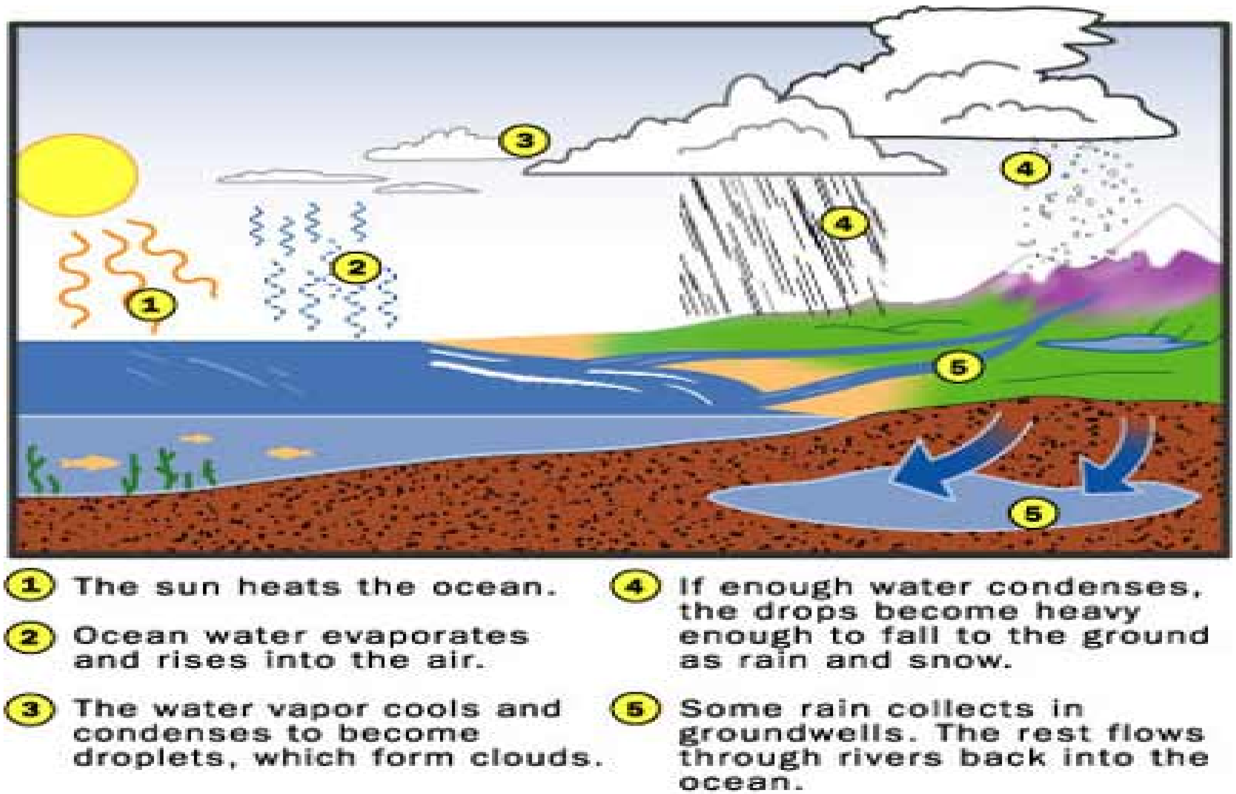


Chemical Weathering: Chemicals react in the environment all the time, and these cause chemical weathering. Major chemical reactions include carbonation, dissolution, hydration, hydrolysis, and oxidation-reducation reaction. All of these reactions have water involved with them.

1. **Carbonation -** when water reacts with carbon dioxide, it creates carbonic acid, which can dissolve softer rocks.
2. **Dissolution-** limestone and rocks high in salt dissolve when exposed to water. The water carries away the ions.
3. **Hydrolysis-** minerals in the rock react with water and surrounding acids. The hydrogen atoms replace other cations. Feldspar hydrate to clay.
4. **Oxidation-Reduction** - water and rock particles react with oxygen. This causes the minerals and materials to rust and turn red.
5. If the area is hot and humid, chemical weathering is more prevalent. If it is drier, physical weathering is more predominant.

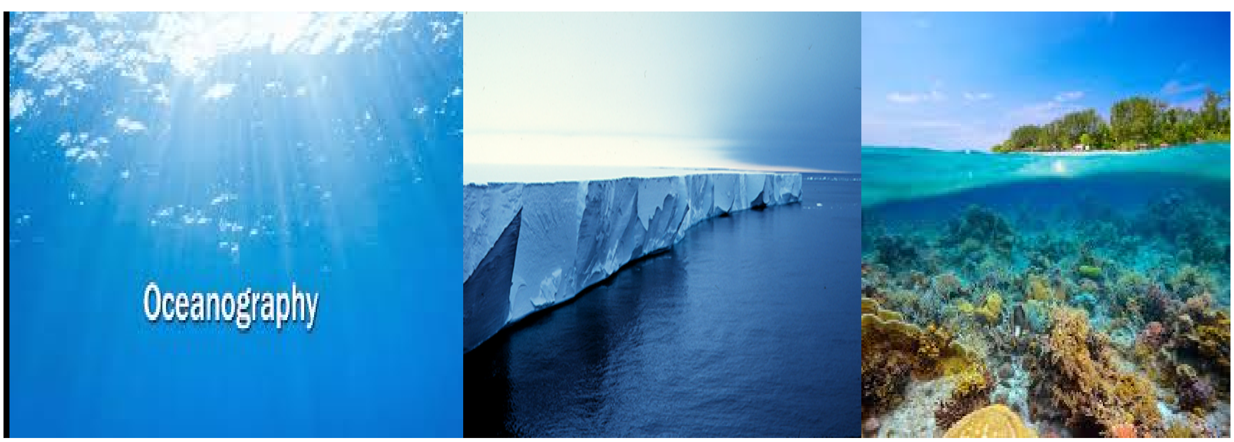
VII. HYDROLOGY

"Hydrology, which treats all phases of the earth's water, is a subject of great importance for people and their environment. Practical applications of hydrology are found in such tasks as the design and operation of hydraulic structures, water supply, wastewater treatment and disposal, irrigation, drainage, hydropower generation, flood control, navigation, erosion and sediment control, salinity control, pollution abatement, recreational use of water, and fish and wildlife protection. The role of applied hydrology is to help analyze the problems involved in these tasks and to provide guidance for the planning and management of water resources".



VIII. OCEANOGRAPHY

Oceanography is the scientific study of the ocean, its inhabitants, and its physical and chemical conditions. Modern **oceanography** began as a field of science only a little less than 130 years ago, in the late 19th century, after Americans, British and Europeans launched a few expeditions to explore ocean currents, ocean life, and the seafloor off their coastlines.



Oceanography is an interdisciplinary science because it applies all the sciences and engineering to the study of the oceans. Oceanography is divided into four categories:

1. Geological
2. Chemical
3. Physical

4. Biological

In addition there are components of engineering, navigation, mathematics and meteorology, marine fishing, ocean engineering.

IX. ATMOSPHERE

An **atmosphere** is a layer of gases surrounding a planet or other material body of sufficient mass that is held in place by the gravity of the body.

1. The envelope of air that completely surrounds the earth is known as the atmosphere.
2. The atmosphere extends to about 1000 km from the surface of the earth. But 99% of the total mass of the atmosphere is found within 32 km.
3. This is because the atmosphere is held by the **gravitational pull of the earth**.

Composition of the Atmosphere

(i) Nitrogen - 78%	**(v)**Neon - 0.0018%
(ii) Oxygen - 21%	**(vi)** Helium - 0.0005%
(iii) Argon -0.93%	**(vii)** Ozone - 0.0006%
(iv) Carbondioxide - 0.03%	**(viii)** Hydrogen - 0.00005%

Carbon dioxide is present in small quantity in the atmosphere

- It is an important constituent of air because it has the ability to absorb heat and thus keep the atmosphere warm, thereby, balancing the heat of the earth.

Dust intercepts and reflects incoming insolation.

- The polluted particles present in the air not only absorb the larger amount of insolation but also greatly absorb the terrestrial radiation.
- Dust in the atmosphere contributes to the red and orange colour of sunrise and sunset.

Layers of the Atmosphere

There are five distinct layers of the atmosphere

(a) Troposphere
(b) Stratosphere
(c) Mesosphere
(d) Thermosphere
(e) Exosphere

Troposphere

1. This is the **first layer** of the atmosphere. It extends to a height of **18 km at the equator and 8 km at the poles.**
2. In this layer, **temperature decreases with height**. This is due to the fact that the density of air decreases with height and so the heat absorbed is less. **It contains more than 90% of the gases in the atmosphere.**
3. Since most of the water vapour form clouds in this layer, all weather changes occur in the troposphere(**"tropo" means "change").**
4. The height at which the temperature stops decreasing is called tropopause. Here the temperature may be as low as **-58 degree Celsius.**

(b) Stratosphere

1. This is the **second layer** of the atmosphere. It extends from the tropopause to about 50 km.
2. Temperature increases due to the absorption of the **ultraviolet radiations** of the Sun by Ozone present in this layer. The temperature slowly increases to 4-degree celsius.
3. This layer is free from clouds and associated weather phenomena. Hence, it provides ideal flying conditions **for large jet planes.**

(c) Mesosphere

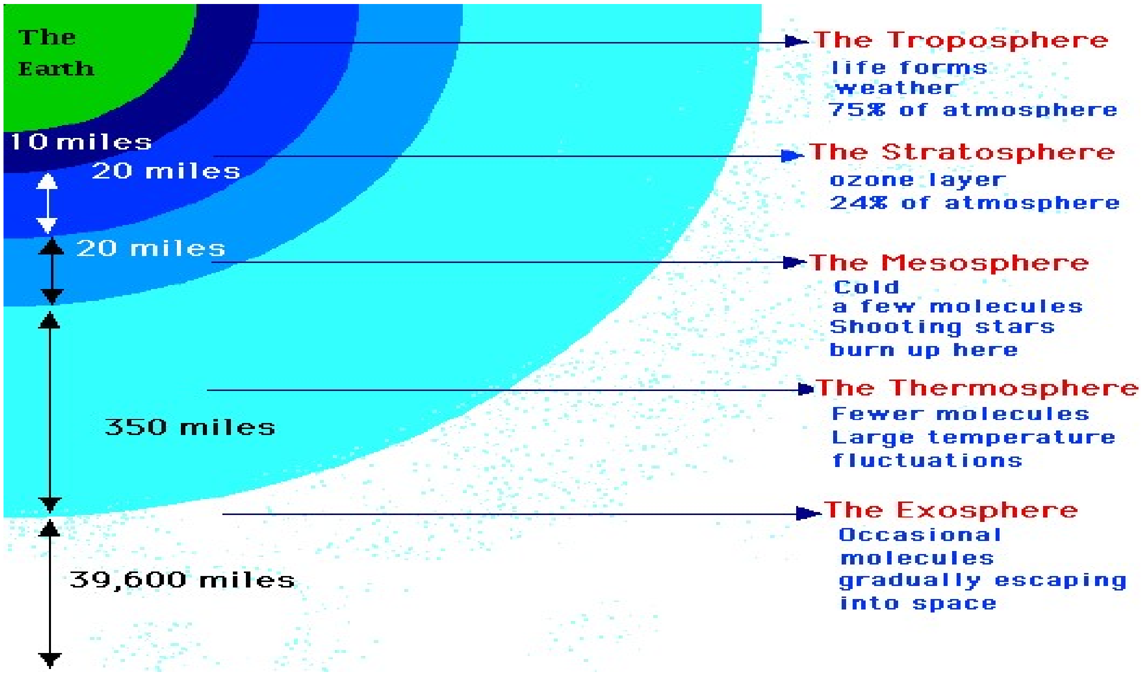
1. Above the **stratosphere** lies the Mesosphere.
2. The mesosphere extends to a height of **80 km.**
3. Here the temperature decreases again, falling as low as **- 90-degree celsius.**
4. The end of this layer is **known as the mesopause.**

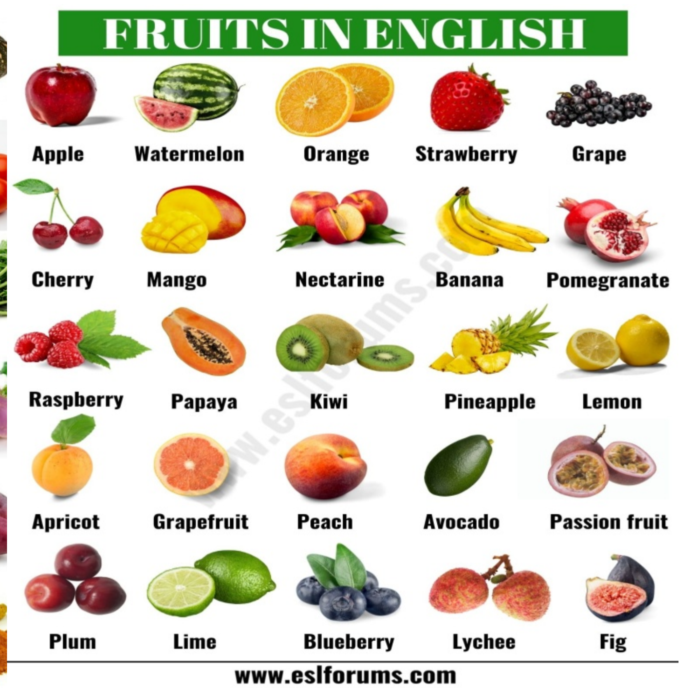
(d) Thermosphere

1. This layer extends to a height of **about 640 km**
2. This increase in temperature is due to the fact that the gas molecules in this layer absorb **the X-rays and Ultraviolet radiation of the Sun.**
3. The electrically charged gas molecules of the thermosphere reflect radio waves from the Earth back into space. Thus, this layer also helps in **long-distance communication.**
4. The thermosphere also **protects us from meteors and obsolete satellite** because its high Temperature burns up nearly all the debris coming towards the Earth.

(e) Exosphere

1. The exosphere extends beyond the thermosphere up to **960km**.
2. It gradually **merges with interplanetary space**.
3. The temperatures in this layer range from about 300 degree Celsius to 1650 degree Celsius.
4. This layer contains **only traces of gases like oxygen, nitrogen, argon and helium** because the lack of gravity allows the gas molecules to escape easily into space.



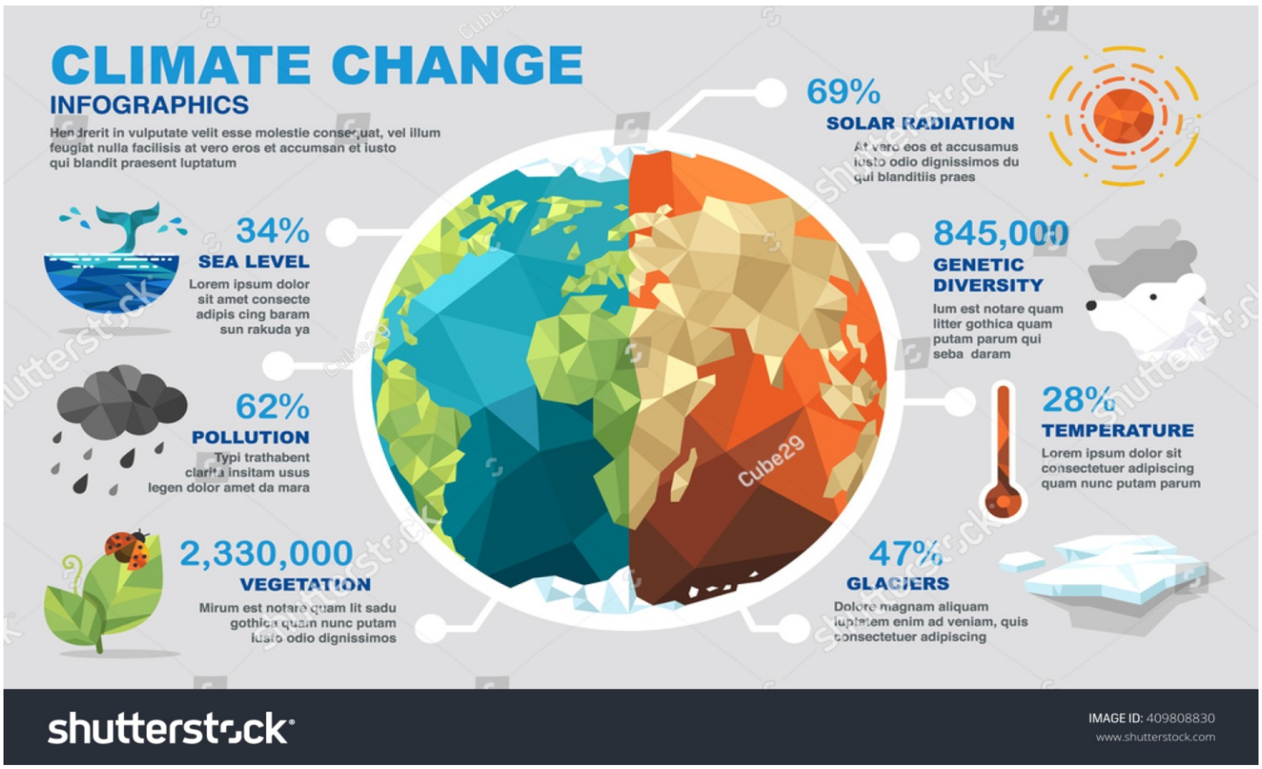


X. WEATHER AND CLIMATE

We can see various conditions of the atmosphere. All days are not same. Some days are sunny, some are cloudy and some are rainy. Some days are cold and some days are hot. Sometimes, it may be rainy in the morning and after sometimes, suddenly the sky becomes clear and the day becomes sunny. The condition of the atmosphere can change from hour to hour or day to day or week to week. It does not remain the same. Weather can be defined as the condition of the atmosphere over a short period of time e.g. from day to day or week to week. Weather does not remain the same and it is not same in all the places. It changes from time to time and differs from place to place.

Climate can be defined as the average conditions of atmosphere over a longer period of time. Climate describes the long-term weather patterns of a certain area for specified time periods.

When the sun heats the water of the ocean, river, lake, ponds, etc. the water gets evaporated. The vapour then rises up into the sky and mixes with dust particles. The vapour then undergoes condensation and as a result, the cloud is formed. Clouds can be defined as the collection of a tiny droplet of water or ice crystals that floats in the sky. Clouds may be in white or grey colour. The clouds become white in colour when the water droplets in the clouds scatter the light which combines producing a white light. As a result, the clouds looks white in colour. When the clouds become thick, the light coming from the sun are not able to pass through the cloud due to which the cloud looks grey or dark in colour. There are various types of clouds depending on the shape, size, colour and appearance. The main types of clouds are cirrus, cumulus, stratus and nimbus.



Rain: As we know that, the cloud is made of very small water droplets or ice crystals. Cloud moves from one place to another. When the cloud gets near to hills, mountains and forest, the cloud gets cooled and changes into rain water droplets which fall down to the earth as a rain. We can see the heavy rainfalls in the month of Asar and Shrawan in Nepal.

Snow: Snow simply means small, soft and white pieces of ice that fall from the sky during very cold weather. It is a precipitation in the form of flakes of crystalline water ice that falls from clouds. Snowfall usually occurs in high altitude regions during the winter season. In Nepal, the mountains are covered by snow throughout the air.

Dew: Dew is a water in the form of droplets formed due to condensation of water vapours. As we know that the air contains water vapours. The hot air contains more water vapour than cold air. In the night, when the hot air comes in contact with cold surfaces, water vapour present in the air condenses on the cold surface in the form of droplets which are known as dew drops. They are seen mainly in the winter season. The dew formation is seen more when the sky is clear and it is seen less when the sky is full of clouds.But when the temperature becomes further low, the dew changes into ice which is known as frost.

Air: The Earth's atmosphere is air. It is a mixture of various gases like nitrogen, oxygen, water vapour, carbon dioxide, etc. Air is a very important resource. It supplies us oxygen which is very important for us. The air consists about 78% nitrogen, 21% oxygen and less than 1% of argon, carbon dioxide, and other gases with some amounts of water vapour.

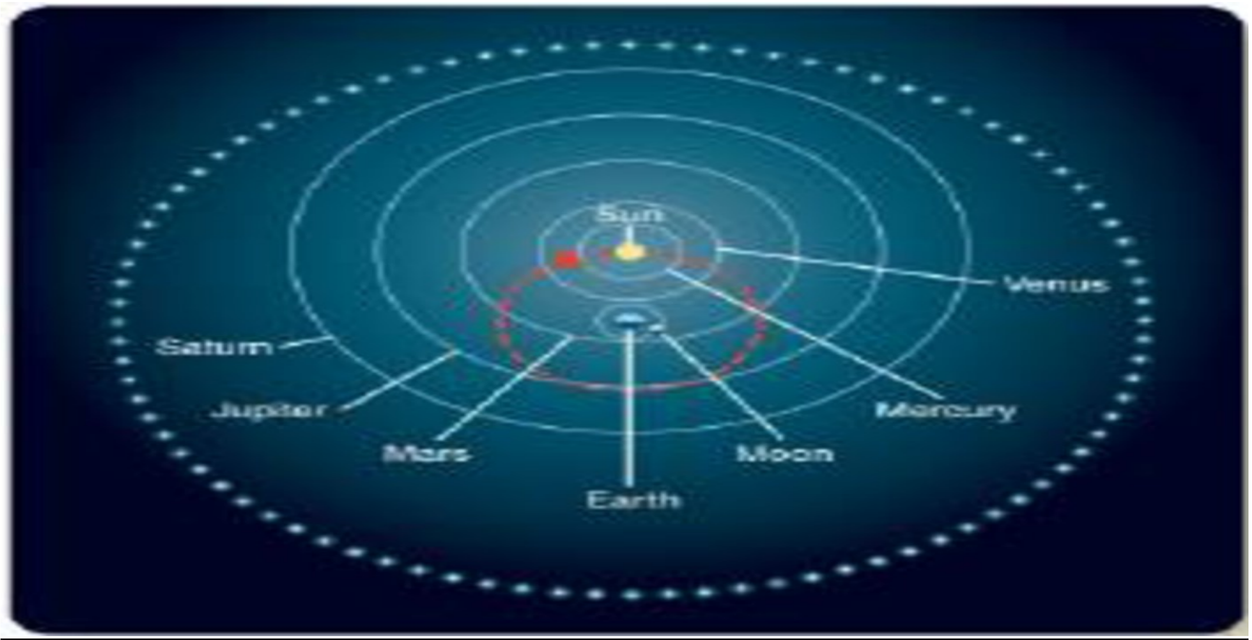
Atmosphere: The atmosphere is a thick envelope of air that surrounds the earth's crust. It is a mixture of different gases like nitrogen, oxygen, carbon dioxide, etc. It also contains water vapour and dust particles. The amount of gases in the atmosphere goes on decreasing when we move upward from the Earth's surface. The atmosphere is divided into five layers which are discussed below,

Movement of Air: During daytime, the air above the land gets heated faster than the air above the sea. As we know that cold air is heavier than light air. The air above the land becomes lighter and start moving upward. The space of the air of land is then occupied by the cold air that moves from sea to the land. This movement of air is known as the sea breeze.The sea breeze can be defined as the movement of cold air from sea to the land during the daytime. But in the night, the land cools faster than the sea. So, the air above the sea is hot than the air above the land. The air above the sea becomes lighter and the air above the land becomes heavier. Therefore, the air above the sea moves upward and its place is occupied by the cold air that moves from land to the sea. This movement of air is known as a land breeze. Land breeze can be defined as the movement of cold air from land to the sea at night. Land breeze and sea breeze are the reasons behind the constant temperature of land near the sea.

XII. ASTRONOMY

The study of stars, planets, and other objects in space Astronomers want to understand the universe and our planet's part in the universe. Space exploration started with its study from earth using telescopes. Our study of space now takes place in space using a great deal of technology. List of astronomers include:

1. Isaac Newton	10. Tycho Brahe
2. Stephen Hawking	11. Arthur Stanley Eddington
3. Galileo Galilei	12. Johannes Kepler
4. Carl Sagan	13. Hypatia
5. Archimedes	14. Ptolemy
6. Nicolaus Copernicus	15. Christiaan Huygens
7. Avicenna	16. Carl Friedrich Gauss
8. Neil deGrasse Tyson	17. Eratosthenes
9. Pythagoras	**18.** Aryabhata



Astronomy is the study of everything in the universe beyond Earth's atmosphere. That includes objects we can see with our naked eyes, like the Sun , the Moon , the planets, and the stars . It also includes objects we can only see with telescopes or other instruments, like faraway galaxies and tiny particles. And it even includes questions about things we can't see at all, like dark matter and dark energy.

Early observers looking at the night sky noticed patterns in the stars . These patterns, which we call constellations, might appear to change place, but they don't change shape. People around the world gave them names (like Orion the hunter or Leo the lion) and told stories about them.

Early observers also noticed some bright objects in the sky that seem to wander around among the stars. The ancient Greek philosophers called these objects "planets," which is Greek for "wanderers." The planets are our near neighbors, and they do move. They orbit the Sun , just as Earth does.

XII. CONCLUSIONS AND RECOMMENDATIONS

1. Geoscience is an interdisciplinary and "socially-minded" area of science.
2. Many aspects of geoscience can impact the general public.
3. Effective written communication is crucial in geoscience because the science needs to be explained to both the public and other scientists.
4. Geoscientists must be aware when writing to these different audiences in order to explain content at appropriate levels of complexity.
5. Most geoscience writing is about contextualizing data and observations. This means first thinking about what you're able to observe, then thinking about the processes that led to your observations, and finally putting the observations in context to see the bigger picture.
6. **Earth Sciences** relate to **the study of earth and its changing aspects**. It deals with subjects like Geology, Meteorology, Oceanography, and Astronomy. There will be studies regarding climate, elevation, soil, vegetation, population, land use and industries.
7. The physical history of earth, its composition, and the changes which the Earth has undergone. You will also be dealing with the physical geography of oceans.
8. There will be projection, design, compilations, drafting and reproduction of maps that is called cartography.
9. Cartography is required under town Planning organizations, forest departments, land survey agencies, defense sector, rail, road and airport authorities, housing boards, and tourism departments.
10. Study the basics of plate tectonics

11. Study the processes which control the formation of mountains and sedimentary basins
12. Study how sediments are formed, transported and deposited
13. Study how rocks are deformed and how knowledge of deformation increases the reliability of subsurface predictions
14. Study hydrocarbon geology
15. Study geology of geothermal energy (from high to very low temperatures)

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