CHAPTER

2

The Natural Realms of the Earth

People who study the Earth – the Earth Scientists – usually talk of four natural realms on the Earth. Realms are areas which have some common features. The earth scientists thus talk of 1. Lithosphere, 2. Hydrosphere, 3. Atmosphere and 4. Biosphere.

You have read much about many of these in the earlier classes but here we will see some broad features of these spheres or realms and how they are interrelated and also how human beings interact with them.

1. Lithosphere: It is the solid crust or the hard top part of the Earth. It is made up of rocks and minerals and covered with a thick layer of soil. (In Greek 'Litho' means stone or rock and 'sphaira' means sphere or ball.) It is not a smooth surface as you see on the globe, but has high mountains, plateaus or high lands, low plains, deep valleys and very deep basins which are filled with water (oceans). Many of these features are shaped by wind and water. Portions of this crust, in the form of dust etc., are mingled with the air too. When the lithosphere heats due to sunrays or cools down, it influences air and water too. We and most other living beings live on this realm. We use the rocks and soils and other things found in this hard crust, in many ways.

2. Hydrosphere: The realm of water is called Hydrosphere. (It comes from the Greek word 'hudor' meaning water.) Some part of the water is found deep down under the earth among rocks (ground water or mineral water). It comprises various sources of water and different types of water bodies like rivers, lakes, seas, oceans etc.

3. Atmosphere: The thin layer of air that surrounds the earth is Atmosphere (It is a combination of two Greek words 'atmos' means vapour). It consists of a large number of gases including oxygen, nitrogen, carbon dioxide, water vapour, etc and also dust particles.

- You have read about mining of minerals like baryte or coal. In what ways do you think this affects lithosphere, hydrosphere and atmosphere?
- Human beings consume a lot of medicines like anti biotics to cure sickness. How do you think it affects the lithosphere and hydrosphere and biosphere?
- You may have noticed that many of the 'scientific' terms use Greek words. Why do you think they do this? Discuss with your teacher.

4. Biosphere: The realm of life including bacteria which live high on atmosphere or in deep oceans constitutes the Biosphere. (From the Greek word, 'bios' means life.) As you may have noted above, life needs the presence of all the three –realms – land, water and air.

Now you can realise that these 'realms' are very deeply interrelated and influence each other. We will study about the first realm Lithosphere in greater detail. The remaining will be studied in the next chapters.

Lithosphere

What kinds of questions do you think would be answered in this section? Tick them in the list given below:

- How it rains.
- Why are there mountains.
- How the winds blow.
- How volcanoes erupt and earthquakes occur.
- Why are there valleys and gorges along rivers.
- How are deltas formed.

Landforms

Lithosphere deals with the land we live upon. As you saw in the last chapter the crust of the earth is uneven, the very low basins are now filled with oceans and then there are the continents. These are called by geographers as the 'first order' landforms or the primary division of the earth's crust into oceans and continents.

Fill up this empty map of the world by naming the continents and colouring them brown and naming the major oceans and colouring them blue.

Map 1: World Map - Continents and Oceans

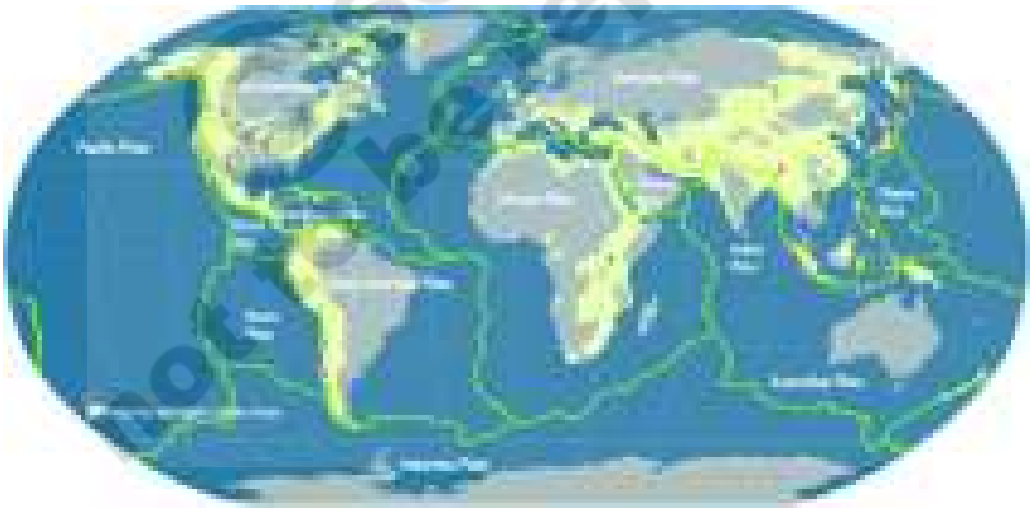
The surface of the continents is not even – they have plain low lands, plateaus and high mountains. These are also in a way a result of the internal processes of the earth as you see below. These landforms like mountains, plains and plateaus are called 'Second Order landforms'.

The Jigsaw Puzzle and the Moving Plates!

In the previous chapter we saw how many continents look like pieces of jigsaw puzzle (Fig. 1.4); how scientists thought that in the beginning, probably all continents were held together and how they broke up and gradually drifted and came to their present places. After years of careful study geologists have concluded that all the continents and even the oceans are actually situated on massive base of rocks called 'plates'. There are about six major plates on the Earth and several minor ones. (The major plates are African, North American, South American, Indo Australian, Antarctic, Eurasian and Pacific Plates. Among the minor plates are the Nazca and Arabian plates). What is special about these 'plates'? These plates actually 'float' on the mantle. They are constantly being pushed and therefore keep moving slowly. They move so slowly that we can't feel the movement. As a result of this movement one plate pushes another neighbouring plate. The region where the two plates meet and push each other, a lot of pressure is exerted by each of them on the other. One plate is pushed under into the mantle while the other plate is pushed up to form a chain of mountains. This movement of plates is called 'plate tectonics'. This process causes earthquakes etc. Now why are these plates being 'pushed'? Who pushes them?

Do you know?

Tectonics comes from the Greek word – 'tekton' meaning carpenter or builder. It is related to the Sanskrit word 'takshan' again meaning carpenter.



Map 2: Map of World plates

Sea floor spreading: Geologists studying the crust under the sea have discovered that under some oceans like the Pacific Ocean there are mid ocean ridges or ranges. These are formed by lava rising up from the mantle. The eruptions on the ridge create new ocean floor made of basalt rocks, which then spreads laterally from the ridge. Thus the mid-ocean ridges contain the newest crust formed on the planet. This fresh crust is being slowly pulled away from the ridge widening the ocean basin. This leads to what is called 'sea-floor spreading'.

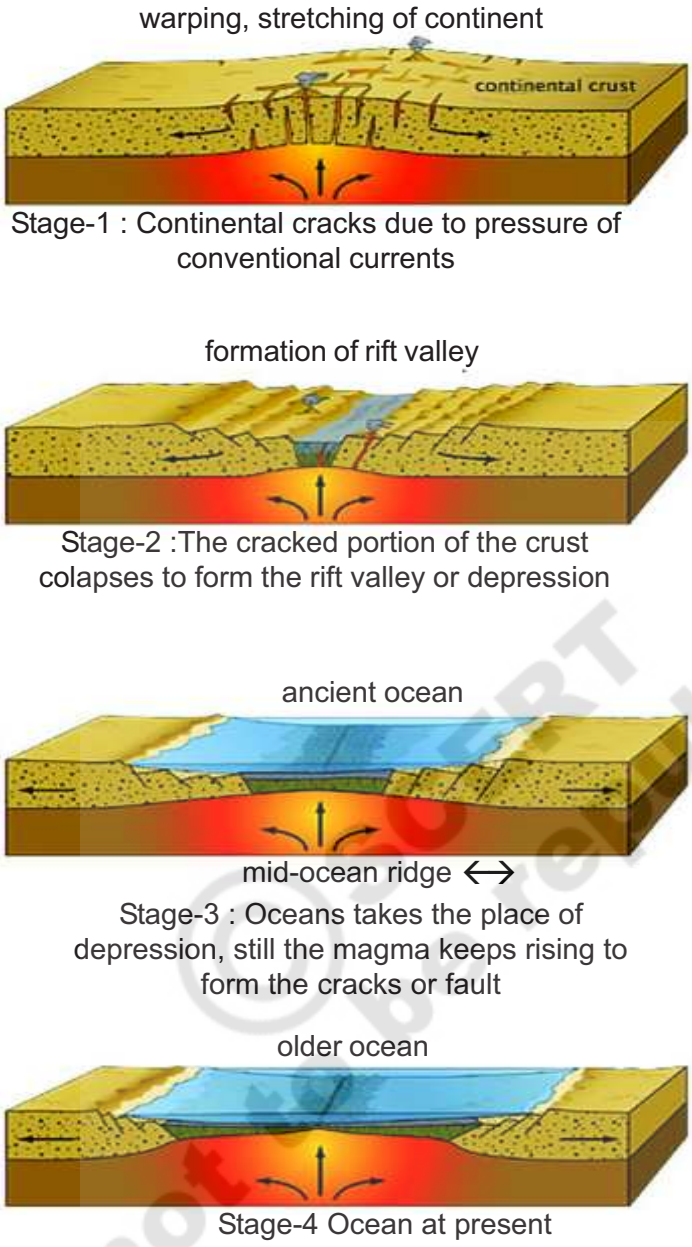


Fig. 2.1: Sea floor spreading

Drama at the margins: The margins of the plates or the boundaries where the plates meet are the sites of highest geologic activity. We saw how new crust is formed leading to sea-floor spreading along the mid ocean ridges. Similarly in other margins of the plates where one plate meets another, often the incoming plate dips under the stable plate. In fact the incoming plate actually goes into the mantle of the earth and becomes molten due to the heat of the mantle. The plate thus going under into the mantle actually pulls the rest of the plate with it. This in turn pulls the newly formed sea floor near the ocean ridges. For example, the Indian plate (on which the Deccan plateau of south India 'rides') pushes the Eurasian plate and goes under it just where the Himalaya mountains are. Just imagine – one day in very distant future the land you are standing upon will go under the Himalayas and join the molten mantle! In fact the Himalaya

- Locate the Himalayas, Andes, and Rockies mountains. Why were they formed in those locations? Suggest reasons.
- Are all rocks on the earth formed in the mid-ocean ridges?
- Geologists have found fossils of sea animals on the Himalayas. Some of these are actually worshipped in many homes as 'salagramas'. How do you think these fossils are there on the Himalayas?
- Why do you think we don't feel any of these mighty changes taking place on the earth? Is it because they don't affect us? Do you think these changes affect us at all?

mountains were formed by this process of the Indian plate pushing into the Eurasian plate (just as if you spread a sheet of cloth on a table and push it from one side it will fold and form mountain like formations). Many of the plate boundaries are also charecterised by volcanic eruptions, and earthquakes. They are the most earthquake prone and volcano prone zones.

Slow Movements and Sudden Movements

In the above section we saw two kinds of changes in the Lithosphere - first the very slow movements leading to the formation of the crust, movement of the continental plates and their eventual return to the Mantle. Second, the sudden and dramatic eruption of volcanoes and earthquakes. The sudden movements can be destructive and cause much damage. At the same time they also lead to changes in landforms.

Volcanoes: See the figure of a volcano. Volcanoes are places on the earth's surface where molten material from the mantle erupts on the Earth's surface. This molten material is also accompanied by steam, smoke and various forms of gases from the depths of the earth. The smoke, ash and dust spreads out in the atmosphere while the molten materials cool and form hard rocks called 'Igneous rocks'.

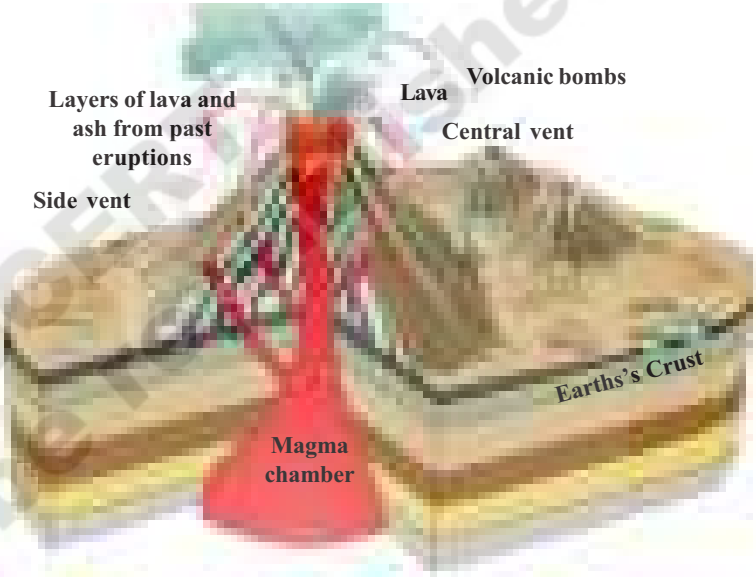


Fig. 2.2: Structure of the Volcano

Some part of the lava may not reach the surface and may cool under the surface and become rocks. These are called 'intrusive landforms'. They are usually covered with older rocks and are exposed sometimes due to

Fig. 2.3: Stromboli Volcano (most active volcano in the world or light house of The Mediterranean sea)

Important volcanoes in the world

Stromboli - Sicily
Mt Pelee - West Indies
Mount Vesuvius - Italy
Fujiyama - Japan
Cotopaxi - Equador
Mayon - Philippines
Barren, Narcondam - India
Kilimanjaro - Tanzania

erosion of the covering rocks. A part of the lava which pours on the surface of the earth forms the 'extrusive landforms'. Not all of them come from volcanoes – some of them are poured out of fissures on the earth's surface and spread all around them. Such flows of lava for example occurred many times on the Deccan leading to the formation of the extensive lava plateau.

- Write an imaginary description of damages that occur due to Volcanic eruption in an area.

The Pacific Ring of Fire

For many decades, geologists noted the high number of earthquakes and volcanic activity occurring around the 'Pacific Rim' – the edge of the Pacific Ocean basin. About three quarters of all active volcanoes in the world lie within the Pacific Rim. The theory of plate tectonics provided the explanation for this pattern. Plate boundaries are found all the way around the Pacific basin. It is along these plate boundaries that many volcanoes and earthquakes occur, giving it the name 'The Pacific Ring of Fire.'

Map 3: The Pacific Ring of Fire

External processes

We saw how rocks and mountains rise up due to the internal processes. External forces like water and air are working vigorously to wear away the surface and the interaction of these constructive and destructive forces gives rise to the great diversity of present day landforms. These external processes on one hand wear away the surface of the rocks and mountains, then they transport the worn out particles and deposit them in low lands and basins. The process of wearing away and deposition causes a general leveling of the surface.

This shaping of the landforms by wind and water are called 'Third Order Landforms' by geographers. These land forms include the features like carved mountains, valleys, deltas, sand dunes etc. Processes like weathering, erosion, transportation and deposition are largely responsible for these landforms.

It is known as denudation process. Denudation is a continuous process. The lowlands what we see today were once mountains and plateaus. Landforms continuously keep on changing due to denudation activities. But these changes occur very slowly. The structure of mountains, plateaus and plains keep on changing through process known as erosion cycle or geomorphic cycle.

How air and water transform the surface of the Earth?

Rocks were formed out of molten materials coming from the mantle of the Earth. These rocks over millions of years have been shaped into valleys and plains of loose soil, river valleys cut into mountains and plateaus, etc. Now, how did this happen?

Actually the hard primary rocks are broken into smaller pieces, these smaller pieces are cut off from the parent rock and carried lower down to other places and deposited there. This process is formally defined as follows:

i) Weathering : The gradual disintegration of rocks by atmospheric forces or weather forces. The rocks when exposed to heat expand and contract when cooled down. This happens every day during day and night and through year after year in summer and winter seasons. As surface rock contracts and expands and contracts again, it gradually becomes brittle and begins to break down. Water and moisture in the air also help this process. Water reacts with the chemicals of the rocks and further weakens the rock. These processes by which the rocks are weakened and broken are called 'weathering'. Look at a large cracked rock and you will find that the colour of the internal core of the rock is different from the outer layer – the colour of the outer layer changes due to this process of weathering. You will find it easier to chip small pieces of rock from the outer layer rather than from the core of the rock.

- Why do you think the rock is harder inside than outside?

ii) Erosion: Flowing water and wind have great power and can slowly wear away or cut away the rocks and soil cover in higher places. Water acts in many ways, as rain, river, flowing ground water, sea waves, glaciers etc. Wind too takes many forms like storms, gusts, steady winds, etc. The active wearing away of the earth's surface by these moving agents is called erosion.

iii) Transportation: The eroded material in the form of small rocks, gravel, mud, fine soil etc. carried by winds and water is called transportation. Rivers and winds and even waves cut soil and rocks from one place and take them to distant places – sometimes hundreds of kilometers.

iv) Deposition: When the rivers and winds slow down, they do not have the force to carry the material any more and they dump them. This dumped debris help to form plains and river basins. Much of it is actually transported by rivers to the sea, where layer after layer of these deposits accumulate in the bottom and over time get transformed into 'sedimentary rocks'.

All four aspects of this process are taking place simultaneously in different parts of the world at different rates, depending on the nature of the slope, the structure of the rocks, the local climate and interference by humans.

Work of Water

Can you recount the course of a river from its source to its end – and guess how it will erode, transport and deposit rock materials?

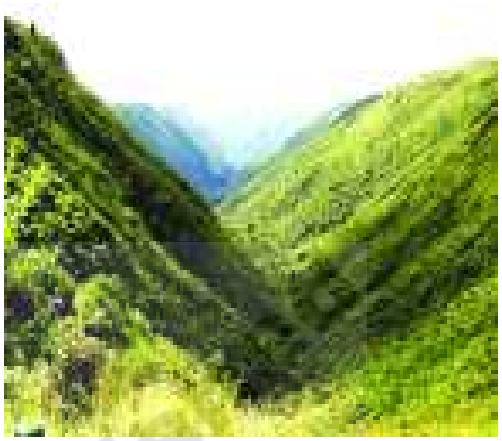


Fig. 2.4: V Shaped valley

The work of a river begins from its very source, in the high mountains. The flow of a river is very swift as it descends the steep slopes and it exerts a great force in cutting the mountain vertically. As a result a deep valley develops, narrow at the bottom and wide at the top. This is usually called a V shaped valley. In this stage water has such force that it can move even very heavy and hard rocks.

Fig. 2.5: Grand Canyon

Do you know?

Biggest Canyon in the world is on river Colorado. The Grand Canyon is 466 kms inlength. Its depth is 1.6 kms and width is 188m to 29km.

- Gorges are suitable for construction of dams – can you tell why this is so?

In some cases where the rocks are very hard, the river cuts a very narrow valley, the sides are so steep that 'Gorges' are formed. The Byson gorge in A.P. on the Godavari, Indus Gorge in Kashmir are examples of this. Another important erosion form is Canyon. A Canyon is characterized by steep like side slopes and may be as deep as a gorge. A gorge is almost equal in width at its top as well as its bottom. In contrast a canyon is wider at its top than at the bottom.

Fig. 2.6: Angel waterfall

The water falls are most numerous in the mountain areas where changes of slope are more abrupt. The water falls with great force and dig out the rock beneath to form a 'plunge pool'.

As the river enters the plain the slope is gentle and the river also slows down. Now it does not have the force to carry heavy particles and deposits them on its banks or on its bed. Sometimes when the river is in flood it has greater force and cuts the soil (called silt) and when it is not in flood it deposits silt. A layer of sidement is thus deposited during each flood gradually building up a fertile flood plain. This is how vast flood plains like the Ganga Plain or the Krishna-Godavari plains were made. When the flood water comes again, the river bed may have become too high as a result of the deposition. Then it changes its course and cuts new path. This results in the river constantly changing its course in a plain. In its flood plain the river often forms meanders – gentle turns like a snake (See fig. 2.8). Due to deposition along the sides of the meander the ends of meander loop comes closer and closer. In due course of time the meander loop cuts off from the river and forms a cut off lake which is called ox-bow lake.

Fig. 2.7: Formation of flood plain

- Explain how the waterfalls are useful.
- Collect the information about the waterfalls in Andhra Pradesh.
- Collect some of the pictures of waterfalls.

Do you know?

1. Highest waterfall in the world is Angel falls - height is 979 mts, on river Churun, in Venezuela.
2. Second highest waterfall in the world is Tugela falls - height is 947 mts - on river Tugela, in South Africa.
3. Highest waterfall in India is Jog fall (or) Jerosoppa - height is 253 mts - on river Sharavathi, in Karnataka.

Fig. 2.8: Meanders

When a river reaches the sea, the fine material which has not yet dropped is deposited at its mouth forming a delta. The word Delta is originated from the Greek alphabet delta (Δ).

- Compare the action of the river in the mountains and in the plains in what ways are they similar and different. How are the two related to each other?
- Why is a flood plain more suited to human habitation compared to mountains?
- What are the dangers of living on the flood plains?
- Recall the life of people in any hills or flood plain you may have read of.

Work of Glaciers

In very cold regions like the Himalayas or the Alps it snows heavily – they get snow fall instead of rainfall. This snow accumulates and hardens into ice. As it accumulates it flows slowly down till it reaches warm area where the ice melts and a small river starts. This is how the river Ganga is formed from Gangotri Glacier in the Himalayas. Slow moving of mass of ice (a river of ice) is called Glacier. The movement of glacier is very slow unlike water flow. The movement would be a few centimeters a day or even less or more. Glaciers move basically because of the force of gravity.

Do you know?

The largest delta in the world is Sunderbans. It is formed at the mouths of rivers Ganga and Brahmaputra. The rivers Krishna and Godavari together make two large deltas in Andhra Pradesh. Look for these on a map of India.

A glacier erodes through a process called 'plucking' in which it lifts pieces of rock and transports them. These pieces of rock and the moving ice together act like a sandpaper on the surface of the rock over which they flow. Just as a sandpaper removes small particles of the wood, the glacier acts as an abrasive and erodes the bed rock. Through this dual process of plucking and abrasion, glaciers create a U shaped valley.

Fig. 2.9: Glacier

As the glacier melts and becomes water, it does not have the force to carry the large rocks which it leaves behind in the form of huge rugged boulders. Smaller particles and pebbles are left on the bed of the glacier. The glacier brings with it small pebbles, cobbles, sand etc. All this debris known as till is acquired by the glacier from mountainous slopes, side valley, floors etc. The till which cannot be carried by a glacier is deposited at various parts of the glacier. The deposition of this till is called moraines.

Melting of glacier

Work of waves

The erosion and deposition by the sea waves gives rise to coastal landforms. As sea waves continuously strike at the rocks, cracks develop in them over time. Gradually hollow like caves are formed on the rocks. As these cavities become bigger and bigger only the roof of the caves remain thus forming 'Sea Arches'. Further erosion breaks the roof and only walls are left. These walls like features are called stacks.

The steep rocky coast rising almost vertically above sea water is called Sea cliff. When sea cliffs weather further they form rugged capes and bays. A cape is head land cutting out into the sea. A bay is wide mouthed recess in the line of the coast. The sea waves deposit sediments along the shores forming beaches etc.

Fig. 2.10: Coastal landforms

Work of wind

In the previous section we saw the action of water on the lithosphere. In this section we shall see the action of atmosphere – particularly the winds. Wind is a dominant agent in the hot deserts. About 1/5th of the world's land is made up of deserts. Some are rocky, others are stony whereas others are sandy. Strong winds carry sand and fine soil which strike the large rocks. These too act as abrasive sandpaper and erode the hard rocks. The wind action creates a number of interesting erosional and depositional features in the desert.

Fig. 2.11: Mushroom rock

Mushroom Rock: Winds erode the lower section of the rocks more than the upper part. Therefore such rocks have narrower bottom and wider top. It looks like mushrooms. So it is called mushroom rocks.

Fig. 2.12: Inselberg

Inselberg: The isolated residual hills rising abruptly from the ground are called inselberg or Island Mountain. They are characterised by their very steep slopes and rather rounded tops

Sand Dunes: Due to weathering and persistent wind action, there is a large accumulation of fine sand in many deserts. These form 'sand dunes'. These are unstable hills of sand which move with strong winds. They form a number of shapes as they move and settle down.

The fine dust blown beyond the desert limit is deposited on neighbouring lands. Usually this is yellow in colour and is very fertile. This soil is called 'Loess'. Loess is in fact fine loam, rich in lime, very coherent and extremely porous. The plains formed by the deposition of loess are called Loess Plains.

Fig. 2.13: Various types of sand dunes in Sahara desert

- Compare the Loess Plains with Delta. What similarities and differences do you see between them?

Action of Vegetation and Human beings

In this section we shall briefly examine the impact of biosphere on Lithosphere. In what ways do you think vegetation – trees, plants and grass affect rocks? They contribute to the weathering of rocks by driving roots into fine cracks or holes in the rocks. They also enable water and moisture to enter into the rocks which further enable weathering. On the other hand the plant or grass cover on soils prevent easy denudation or transportation of soil by wind or water.

- Can you discuss in the class how the following human actions impact the lithosphere?
  i. Mining ii. Building cities with bricks and cement iii. Agriculture iv. Dams

Human beings especially after the Industrial Revolution have had a major role in transforming the crust on which we live.