Geomorphology
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Lecture 7
Weathering & soil Formation Introduction-I

So, friends welcome to this class of geomorphology and in this class we will deal with weathering and soil formation. What does it mean is weathering important for you? And if it is important then why it is important does weathering affect your daily life does weathering affect your food production does weathering affect our neighbourhood relations? Does weathering affect our Heritage site. So, in this class will deal all this subjects and will try to answer all the questions with suitable examples.

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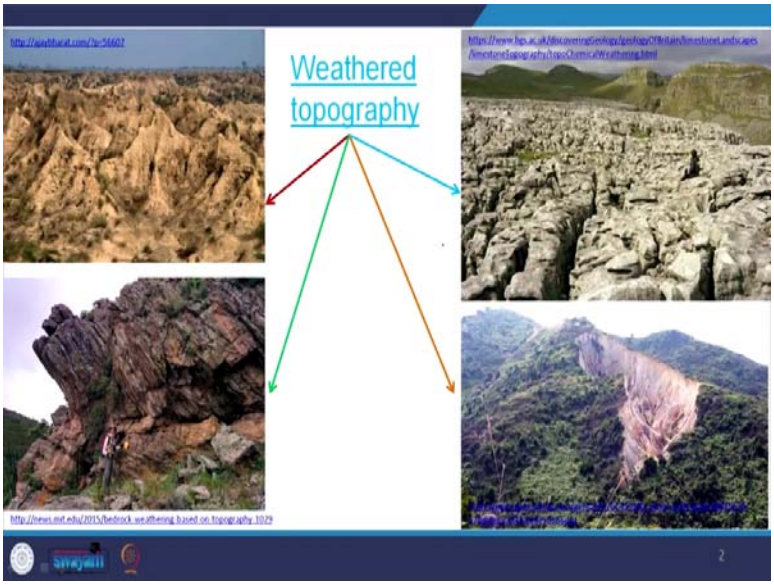

So, before proceeding to this class of weathering now, look at this 4 photographs left hand side this is the weathering topography. mostly it is found in the Yamuna river bank is called Chambal valley and this is presenting this Badland topography. It is simply is weather zone. It is chemically weathered zone are physically weathered zone. What is chemically weathered zone and physically weathered zone, we will discuss in the later times.

But overall if you see this photograph it is topography which is undulating it is not plane. Similarly second photography if you see here the right hand side this photograph represents the

weathered topography of limestone terrain and you know, the limestone it is mostly chemically very vulnerable for weathering compared to siliciclastic rocks, like sandstone. This limestone is chemically very vulnerable to weathering.

That is why most of this weather topography in the limestone region is found due to chemical weathering and third photograph in this corner one. It is a weathered profile of a hard rock. It is of quartzite which contains iron that means if you remove this weathered product if you remove this metamorphic effect earlier it was a ferruginous sandstone and finally due to weathering it forms quartzite and which is iron leached that is why red colour is appearing.

And the 4th one this right corner in the bottom this is a part of the hill slope, which is weathered due to mass wasting. So, now the question arises if these are the weather topography and all this weather topography they represent different types of weathering different agents are involved in the weathering of this topography. So that means now, we should have a topographic and we should have a weathering agent due to this weathering agent either physically or chemically biologically or in combination of both these topography getting peneplained.

So if you remember our earlier classes when we are talking about the davis geomorphic cycle. Davis geomorphic cycle says in a time span the mountain building takes place and with a large time span this mountains get eroded and finally it reaches up to the base level. In this weathering topography there are different levels of weathering and erosion has been taken place and finally some important part of the process they are reaching too.

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So to explain all those things lets consider again 4 photographs the left hand side photograph this was this is part of our Indian continent in the east coast of India and near to Visakhapatnam here it is mentioned near to Visakhapatnam it is the granite granitic rock, intrusive rock and we know the intrusive rock they form at considerable higher temperature and pressure below the earth crust some kilometer below. And once they reach to the surface they are not vulnerable to withstand the reduced temperature and pressure.

That is why they try to weather, this weather again either it is physically or chemically that will discuss in later class but in this particular photograph if you see there are certain line. They are not lines actually, they are the layers different layers. That means I want to say the granite it is exposed as the eastern boundary of the Indian subcontinent near to Visakhapatnam in the Eastern Ghat region there weathering their removing the material layerwise. So there is Layer type of removal of material from this Rock.

Second photograph if you see here this one, this is 2 assign it 2 number. This is a photograph of basalt. It is an extrusive igneous rock so extrusive igneous rock that means it formed at the surface temperature and pressure condition when the Magma pours out from this mantle from the subsurface level it form basalt mostly it is mafic rock. Now you see here is a clear line demarcating a boundary what is this line means, below this line the rocks or the basalt. It is unweathered or relatively less weathered.

But if you consider the upper part of this photograph, you see there are mostly rounded parts that are mostly rounded part. And within the rounded part you will see there will cabbage like appearance. So that means that is a cabbage type of weathering there is a layer type of weathering which are spheroidal. This is called typical spheroidal weathering. So, spheroidal weathering it is typically found in the basalt, and if you see the cabbage like layer of Rock that is getting removed.

Now the third photograph here, third photograph is also from Visakhapatnam coast. And you see this is Bay of Bengal and this is this side is the continent and this Rock representing khondalite. Khondalite, you know, it is Sillimanite bearing Rock which is metamorphic rock. And this you find this main thing of showing this figure is, here if you see it is a natural Bridge. Natural bridge is due to weathering only.

And fourth photograph it is called Talchir sandstone from Gondwana it is from Maharashtra also. Now you see there are groves and ridges. So, these groves and ridges may be due to weathering glacial environment, but this is due to chemical weathering of calcareous sandstone. So Now I want to say there are 4 photograph of different part of the Indian subcontinent it is showing different type of weathering of different type of rocks.

So, that means I want to say we have different agents their specially and temporarily working 24 into 7 to make the rock peneplain and to make the surface down. So, this total system that is either it is occurring physically simply breaking down of rock or it is occurring chemically that means with chemical reaction with the reagents atmospheric agent or water or some acids like that. Or it is biological that means that the involvement of human being either involvement of the any organism in the bacteria involvement of this trees, whatever may be.

So, that is why either physically chemically or biologically the rocks are getting weather and shape is continuously changing, shape is continuously to changing it has to be remembered here because if you remove the weathering effect from this rock, the rock was somewhat differently behaving and this weathering before when the formation of this basalt there was no spheroidal

weathering. During formation of this granite there was no layer type of these discontinuities their existing.

During formation of the khondalite there was no natural bridge occurring. During the formation of sand stone there was no grooves and ridge structure. So, that means these structure there later imposed to the rock due to some agents which are called weathering agents.

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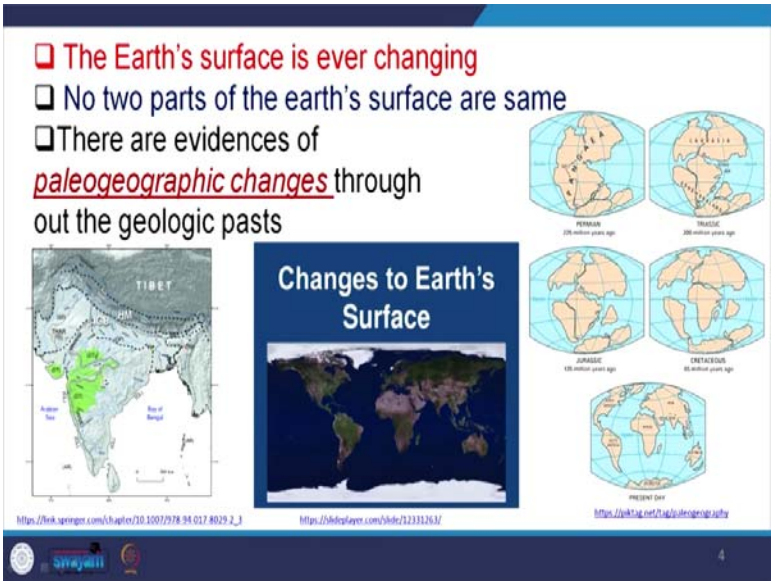

Now the earth surface is ever changing that means no 2 part of the earth surface are same. There are evidence of paleogeographic changes throughout the geological past it is very important notice here there are evidences of a paleogeographic changes. Paleogeographic changes that means if you consider our Indian context only. In Indian context if you remove 55 million years from this Geological time scale we will not find the existence of Himalayas in the Northern part.

So, instead will find this occurrence of this ocean that is called Tethys ocean. Now imagine when Tethys ocean was existing in the Northern part the rivers which are originating from the central part of the India they might have debouching their sediments to this Tethys ocean so that means earlier a ocean was existing. There is geographically decreased part existing. But now due to this collision of Indian and Eurasian continent now this is Tethys ocean modified gradually and finally it is converted to Himalayas this is paleogeographic changes.

Similarly if you consider the coastal parts in the coastal part if you remove 10000 years from the geological time scale you go to the Holocene. In the Holocene there was at the end of the Holocene was marked due to the deglaciation. Soon glaciations was there, the whole earth surface was glaciated and all this continental part it is occupied by glacier ice. So that is why this ocean level this mean sea level was much below 100 metres below at the present time. So when the see was 100 metres below at the present sea level rivers whatever the taking their sediments there are debouching at the deeper part of the ocean, deeper part of this bay, deeper part of the sea.

So, now due to increase of sea level this sediment which has deposited by the river then they are submerged and finally a fluvial environment or a deltaic environment which was existing 10000 years back now it is re-occupied by the marine environment. And finally if you further increase the sea level this fluvial environment again retreat back to continent ward and the marine environment again encroached to the continent ward.

So that means this is paleogeography changes. How the geography was distributed how the different agents are distributed because in the paleogeography condition all this weathering agents either it is river or it is Glacier or it is wind or many other agents also. They have their restricted environment and those restricted environment. There are different setups, so one environment if it is encroaching to different environment that means it is clear indicating that there is a change of paleogeography.

Similarly in the earth crust there are many times it has been noticed. We have geological evidences we have paleontological evidences we have geographical evidences and that there many other evidences available that itself there is change in land and sea distribution in geological past. For example if you see here 225 million years ago, this was the land and sea distribution 200 million years ago this was the land and sea distribution.

135 million years ago this was the land and sea distribution as such and 65 million years ago this was the land and see distribution and this is the present land and sea distribution. That means I want to say from present to 225 million years if we analyse we compare the land and sea

distribution you will find huge change. And once the land and sea distribution changes. The environment changes the climate changes the geographical position of one agent changes to other agent it is occupied.

So, that means I want to say with the change of paleogeography the weathering agents or the agents which are continuously working to peneplain the earth surface there domain also restricted. That is why paleogeographical changes with time. It refers to the change of weathering agents one domain to another domain. Different places are dominated by different geological agents and style of working is very different. It is very important to say.

This style of working is also different it is also important. For example we say we consider here three weathering agents one is river, one is wind one is glacier. Here they are the three prominent weathering agent. Glacier it is occupied at the higher latitude and higher altitude for example the Indian context if you say Glacier mostly higher Himalayan system. So, their domain is restricted there and their style of working is also different.

By looking a valley by looking is sediment by looking erosional topography or by looking at the depositional system. We can predict which type of geological agents is involved for their formation because the style of working is different. The river it creates V shaped valley and glacier it creates U shaped valley is it not. A glacier which cuts up to the deeper part of the earth crust but river cannot, wind cannot.

Similarly the wind which produces more very fine materials very highly rounded very highly texturally matured material. However, if you see the Glacier it will be highly angular fragments highly texturally immature, mineralogical immature and compare to the river part it is considerable somewhat better than this glacier. It will create a valley which is considerable depth which produce sediments which are mineralogical relatively more mature than Glacier.

So that means I want to say we have different agents their continuously working. But their style of working is different. So that is why by looking the topographic by looking their product process and product relationship we are talking by looking the product we can say what are the

processes involved in the formation. So, that is why the style of working of different agents are different in terms of weathering is concerned.

And this weathering some of this weathering parts they some of these weathering agents they work somewhat slowly and some of the weathering agents they work very fast for example water, wind, chemical agent, gravity they are slower process. But there are exceptions for example water.

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Suppose if we consider water why water? River water it is flowing millions of years, 1000s of years, lakhs of years. So, this carrying out sediment, it is transporting sediment from one place to another. average sedimentation of an area for annually it is few millilitres per year it is a slow process. But exceptions are there for example Kedarnath tragedy or there is a flash flood in the upper reaches it will create metres of sediments within a minute on hour.

So, though this water system. It is a slow process, but there are exceptions within the exceptions you will find the fast process within that. Similarly wind erosion it is a slow process to peneplain a system it will take millions of years, but exceptions are also there, dust winds they will create huge sediments within a minute second. Similarly chemical agents it is a slow process gravity though it is a slow process, but sometimes landslides, gravitational failure within a minute it will change the topography.

The whole topography can be changed within a minute or hour. And some of the fast process are there like landslide. Landslide is a fast process, very fast if you see your previous slide here, here the landslide it is here within a minute, within a hour whole system will be changed whole topography will change. then tectonic forces, tectonic forces they are fast process though they are considered? Sometimes it is slow process because tectonic movement 5 centimetre per year 3 centimetre per year 2 centimetre per year.

But there are certain events sometime occur that will change the topography Nepal earthquake huge fracture within a minute. So, some of these weathering agents they work very slowly and some of them work very fast but exceptions are always there. So what was their product if they are working 24X7 either slowly or fast this laid to the change in geography of region change the geography. They always try to peneplain because nature never wants its surface to become rough it always wants by their agents to change the surface to peneplain the surface 24X7.

For example here three photographs are given one is 1890 you see this mounts within this sea and 1910 that means after 20 years here see size of the mount and 1970 after 60 years you see the size of the mount. The place remains same the agent remains same but the topographic size gradually decreasing. So, that means I want to say in a place these processes and products they vary with time or the process remain same the size of the product vary with time.

That means gradually this weathering processes they are working 24X7 to make the system peneplain from huge Mount gradually decrease size and gradually decrease size. If it noticed further. Suppose in 2019 probably this mount would not have been here. So, that means this is a gradual process this geomorphic system their working to make this system peneplain to change the geography.

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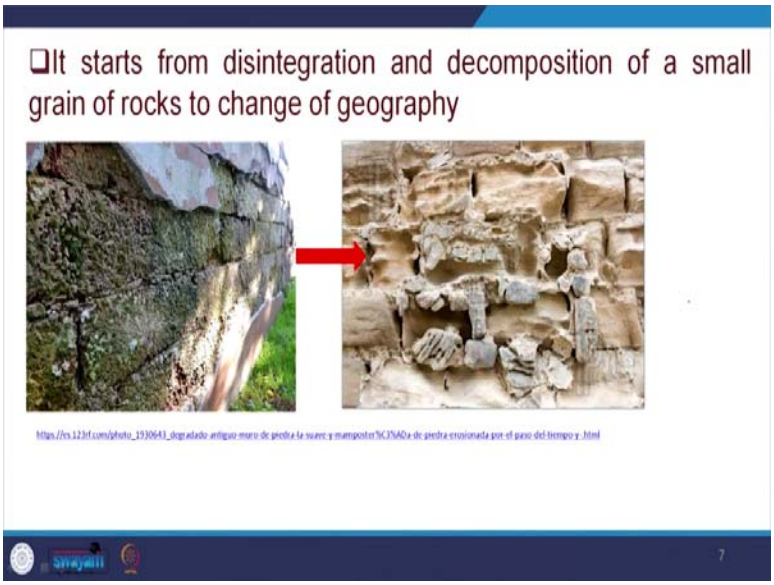

And if this is so now the question arises what scale this weathering process works. Scale means you see the weathering process it starts from small grain and its changes geography that means from minute from the tiny size to regional size. So if you see here for example, it is a wall constitute of bricks now after 100s of years. You see the situation of the bricks and finally what are the product, product in soil is grains, small grains the grains that will be transported from here. that will be removed from here and deposits somewhere else that will as a part of this soil formation process.

So, that means this weathering though it is working 24X7 it scale it can be of tiny size to scale of mountain size at scale of regional scales. So that is why the weathering do not bound itself with environment.

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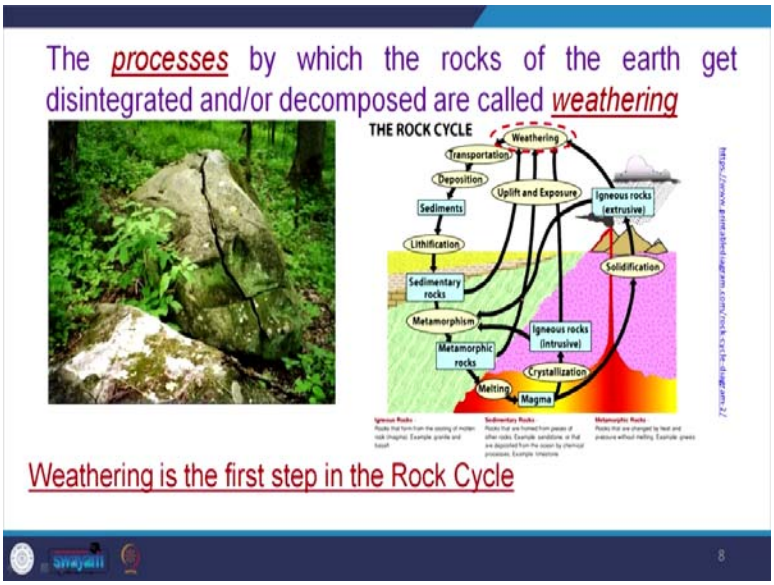

And the process by which the rock of the earth gets disintegrated and decomposed are called weathering. This is very important, the process by which the rocks of the earth gets disintegrated and decomposed there are two things here to be understood. Disintegration that means simply breaking, simply breaking without changes composition. Decomposition means it changes its composition. The first part only the physically the size is reduced without changing its composition without changing its mineralogy.

But in the second case decomposition here the size may reduced and the composition may reduced. So that is why weathering not only confined only the size reduction weathering also involves the composition change. So, this weathering which is responsible for composition change. It is called chemical weathering and which is involved only disintegration size reduction. This is called physical weathering or mechanical.

So, irrespective of its process it is irrespective of process either physically or chemically or in the combination of both. The process by which rocks of this earth crust gets disintegrated or decompose that is called weathering. In weathering is the first step of rock cycle, rock cycle if you see here this is very nice figure. Here you see in the rock cycle we consider three types of rocks igneous rocks that also get weathered, metamorphic rock get weathered, sedimentary rock get weathered. So the weathered product what will be the product the product will be soil.

So that means irrespective of rock types if it is getting weathered it is decomposing or disintegrated. So this is decomposed product or disintegrated product that is giving the product of weathering and final it is the soil. In the initial when started the class we were discussing whether this weathering it is affecting our daily to daily life? Yes it is affecting. How? weathering it controls our food production. Weathering controls our soil quality, weathering controls Whether what type of soil either the soil will retain water within it or not.

So that means once the soil properties is getting changed the crop property also getting changed. So, our daily life our food quality our food production, what will consume daily that will also defined by weathering only. Similarly we have different mineral resources like bauxite deposit in east coast Khondalite, bauxite deposit in Maharashtra that is in Basalt. Copper deposit Rajpur-Dariba. So all those products this is due to weathering only.

similarly this soils on which were doing agriculture it is a product of weathering. Terracotta is the product of weathering. If had weathering had not been there so that means rock is fresh not weathered no soil, so barren rock body would have been there and finally barren rock that means no vegetation no cultivation no crop no food no existence of the life. So that means weathering it is a good factor for our food production our soil quality management.

So that is why weathering it is affecting our daily life. National economy it is affecting how? that Few minutes back we are talking about our mineral resource. mineral resource That means we are adding our wealth to the national property. So, had weathering not been there, there would not have any bauxite deposit in either it is in Kandamaruthan in Eastern Ghats or it is in Basalt of Maharashtra so due to weathering it happened it possible. Similarly china clay deposit china clay deposit is a product of weathering is it not feldspar and other rocks they are chemically leached chemically weathered.

And finally product of this china clay, similarly the copper deposit it is a product of chemical weathering. So we will talk about mineralization and weathering will talk in detail. Here I want to say whether weathering affects our daily life, weathering affects our national economy

weathering affects our crop production weathering affects our food consumption, so all this things that affected by this geological process, which is called weathering.

So this is the first step of Rock cycle. Now if you see here igneous rocks extrusive igneous rock, it is getting weathered transported deposited and create sediment, lithification and sedimentary rocks. Similarly metamorphic rock, it is get weathered again the same process continuous and finally sedimentary rocks. Intrusive igneous rocks it get weathered and finally is due to weathering again through same process it creates metamorphic rock.

So that means I want to say either it is extrusive igneous rock or intrusive igneous rock metamorphic rocks, sedimentary rock, all those types of rocks get weathered with time and the product is our soil development. More this weathering more thicker the soil and more mineral constituents that accumulates in the soil making the soil more fertile. So, this is the product of weathering, advantages of weathering.

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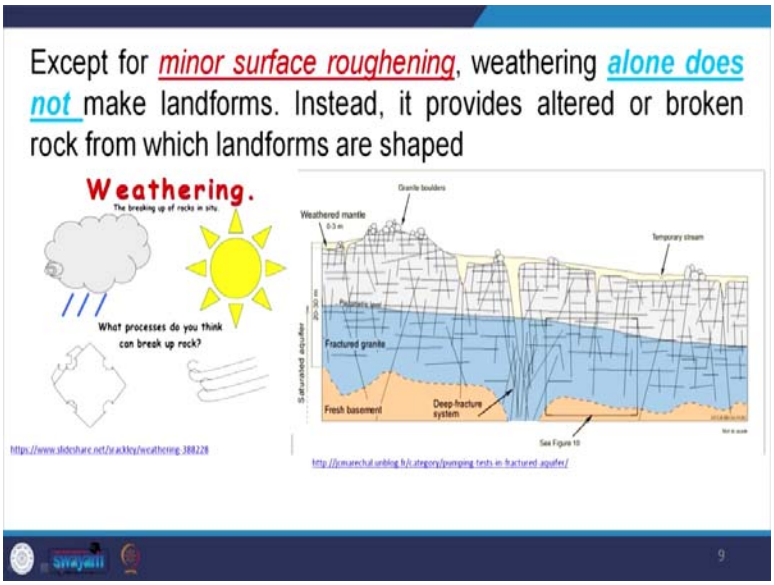

So except minor surface roughening weathering alone does not make landforms mind it. Weathering alone does not make landforms. So, what is associated with weathering? It provides only broken rock. So that means there is another agent which is associated with weathering that is called erosion. So, weathering and erosion they combinely work together to make the earth

surface peneplain. Weathering itself is not able to do it because weather products that if I discuss this difference between weathering and erosion.

Weathering is the only disintegration or decomposition at in situ that means the product that remains at the same place. But as per is erosion is concerned erosion remove the material from the weathering site. So, it is removed means it is a considerable distance. It is called erosion. Weathering alone is not responsible for landform development or landform modification. It is weathering and erosion both are simultaneously working together to make the surface peneplain.

Now if you see here this diagram this is weathered mantle and it is temporary stream is there then granite boulders are there? So in the next class will talk about how this granite get weathered and what are the product formed? And how these products are removed from this place and how the landforms are formed due to erosion. How the landforms are formed due to weathering and in the detail will discuss in the next class. Thank you.