Geomorphology
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Lecture – 14
Factors of Weathering

So friends welcome to this series of geomorphology and today we will discuss about some factors that are responsible for weathering. If you recollect your last class we are talking something about this mineral composition, the height and the rock structure either primary or secondary which are responsible for weathering and today we will continue with that and some other factors has to be discussed here.

So at the 5th one that we can say it is the vegetation. Vegetation if you know nowadays a plantation drive is going on to resist weathering or to counter the weathering. However geologically if you analyze vegetation has both negative and positive effect. How? Positive effect means it binds the soil mostly the positive effect is felt in relatively flat terrain. However, if the vegetation is there in a sloping surface it has negative effect.

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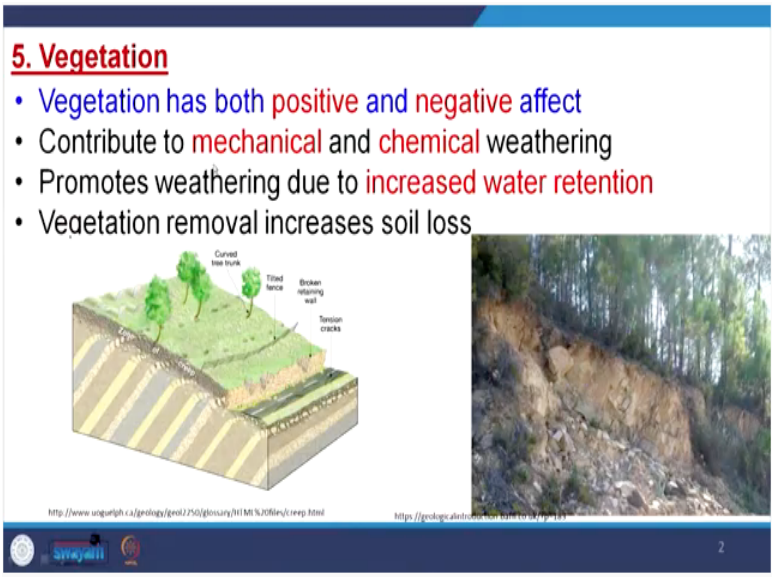

Negative in the sense it is contribute mechanical and chemical weathering. Mechanical weathering that means through the rooted plants through the roots it breaks the rocks into pieces and the chemical weathering if you remember our chemical weathering class there is a sphere

that is called Rhyzosphere where these bacterial activities is there and through the bacterial and similarly the plant root it negatively charged and that is why this is promote chemical weathering.

So mechanical and chemical weathering both is promoted by presence of plant. Then it promotes weathering in increased water retention. We know the vegetation root it retains water within the system. So once water remains and we know the water is the main culprit for weathering. So once in a rock the water is retained that means it promotes both physical weathering and chemical weathering.

Then vegetation removal increase soil loss. Suppose where it is negative impact. If we remove the vegetation there will be soil loss. So that is why both positive impact is there and negative impact there with the vegetation.

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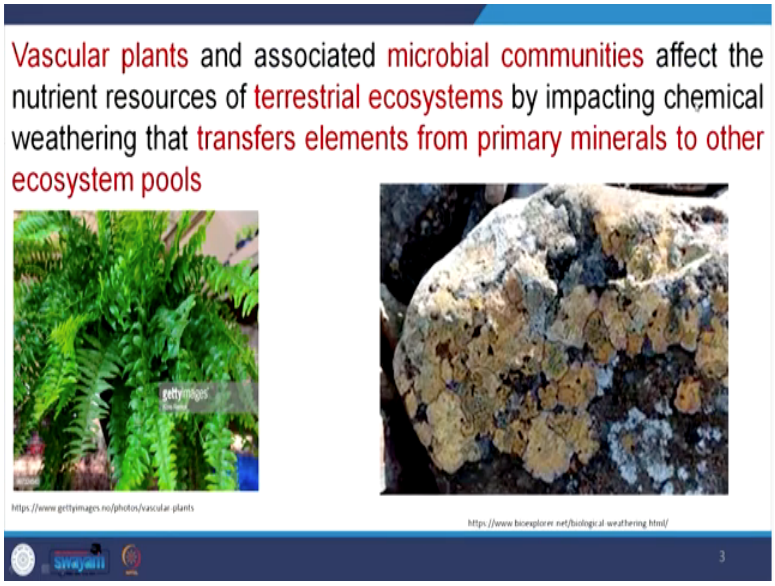

Then it is a very important to note it here that the vascular plants and the microorganisms, the micro communities they maintain the food chain of the ecosystem. They maintain the mineral supplements in the ecosystem. How? If you see here vascular plants and associated microbial communities affect the nutrient resources of terrestrial ecosystem by impacting the chemical weathering that transfers element from primary mineral to other ecosystem pools.

So once we have the vascular plant and micro communities they are the algaes they are growing on these rocks. They break the rocks chemically into different supplements, different mineral constituents and those minerals the free-minerals the free-elements they transfer from one place to another place through physical weathering, through rivers. through winds so different agents are there and one place from these rocks to other place from this Earths that means nearby area they spread and finally this nutrient supply becomes uniform.

And the supply remains there until unless the plants growth or the micro communities they grow on the rock surface. So that is why I want to say this micro communities and the vascular plant they becomes active they are very responsible for nutrient supply the mineral nutrient supply to these ecosystem. Then climate, climate is another important role.

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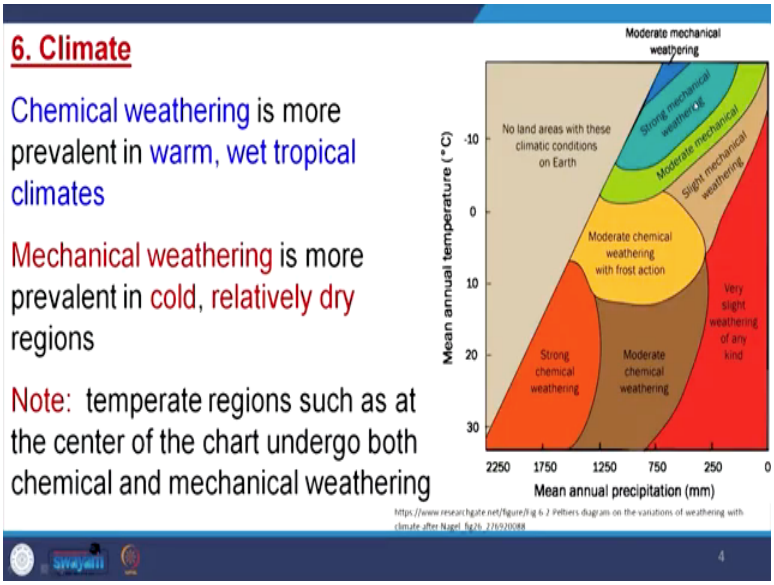

If you see here the climate mostly defined by this heat or this atmospheric condition and rainfall. So now here if you see the temperature mean annual temperature it is -10, 0, 10, 20, 30 here rainfall in millimeter. Now if you arrange those temperature distribution and rainfall distribution the whole earth can be divided into different climatic segments. If temperature is very less <10 degree and here this highest rainfall 2250.

So this type of environment no land area in these climatic conditions on the earth. So present day climatic conditions if you analyze and you want to fit on this earth surface fit in this graph you

will not find these type of climatic conditions. However, if you see here different colors are assigned to define different climatic condition. Here rainfall 0 to 250 mm and mean annual temperature is 20 degree to 30 degree.

If you see very slight weathering of any kind that means low rainfall only temperature is there 20 to 30 degree that means room temperature near about. So there will be no weathering but if you see here high rainfall that means 1750 to 2250 high rainfall and high temperature here you see strong chemical weathering. So that means the rock will be chemically weathered at high rainfall and high temperature in it. That is warm and humid climate.

So warm and humid climate they are more responsible or they are responsible for more chemical weathering. Similarly, strong mechanical weathering if you concentrate here we have rainfall varying from 1250 to 250 mm and temperature about -5 degree to -10 degree or -20 degree. So here strong mechanical weathering. So that means colder these region colder the temperature colder the environment it will promote more mechanical weathering.

Warmer this environment it will promote more chemical weathering and in between moderate chemical weathering with frost action, slight mechanical weathering, moderate chemical weathering, moderate mechanical weathering. So depending upon the distribution of temperature, distribution of the variation of temperature and distribution of rainfall this whole earth system can be divided into different weathering groups weathering domains.

And each domain the product is different. Chemical weathering is more prevalent in warm wet tropical climates. Mechanical weathering is more prevalent cold relatively dry region. Here it is worth note that temperate regions such as in the central part of this chart undergo both chemical as well mechanical weathering here. Moderate chemical and moderate mechanical weathering that means here in the central part of this chart.

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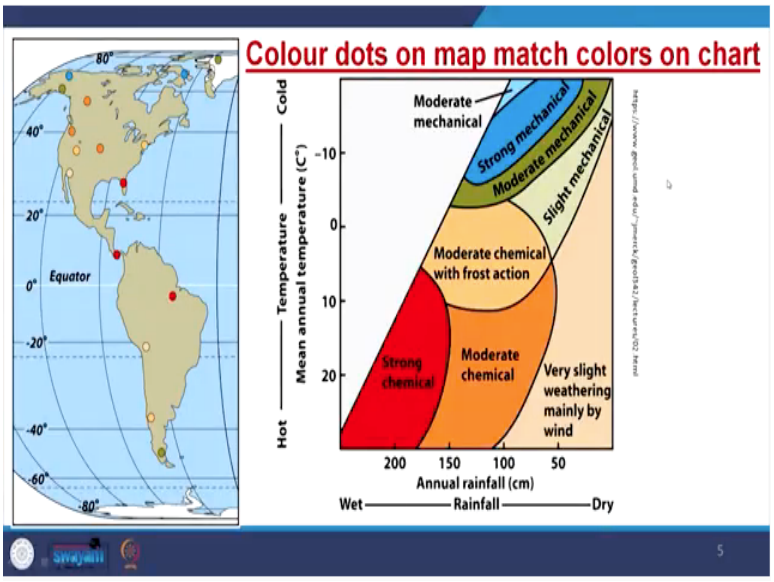

If you see both chemical and mechanical weathering both are prominent. Then these graphs if we want to transfer it in the present day earth scenario we can say here these dots the color of these dots they are corresponding to the color of this side figure. So here you see strong chemical weathering these regions that means close to equator. Here 0 degree equator is there from equator to -20 to 20 degree or even a 30 degree.

Some 30 degree to 30 degree latitude both sides north and south. They are more prone to chemical weathering because high rainfall and high temperature so warm and humid climate. Similarly, if you concentrated moderate chemical weathering again here we are going this is moderate chemical weathering here, here and here. So moderate chemical weathering is there. So that means just these 2 continental shown here that means it is valid for the whole globe.

Similarly, here moderate chemical with frost action if you see here moderate chemical with frost action. So that means those color of this dot that are corresponding to this color of this weathering system here. And this blue dots are here strong mechanical weathering because it is the permafrost region northern part. Similarly, in the southern part also we will get here. So that means those which are at this close to equator they are more prone to chemical weathering.

And we know the chemical weathering more chemical weathering more deeper the soil development is there. So in the next class when we will talk about this soil formation and these weathering product we will discuss in detail about this.

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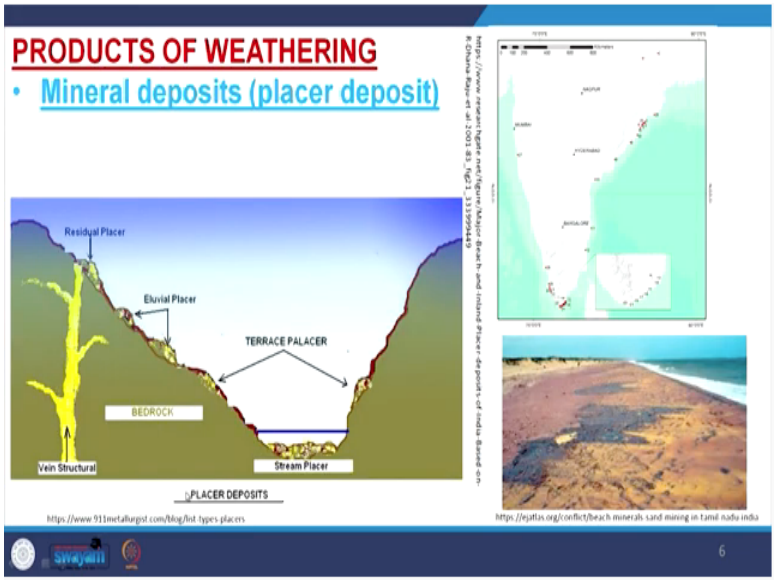

Then what are these product? So far we are discussing about weathering, physical, chemical, biological combination of those. What is this product? What is this utility? So first and foremost product is the mineral deposits. Mineral deposit there are 2 types of mineral deposit one is called primary deposit which is formed or the mineral formed during the formation of the rock another type of mineral is called secondary mineral deposit that means secondary type of deposit.

That means after the rock form past rock form then the mineral form. Mostly the weathering is responsible for secondary mineral deposit. So if you see here placer deposit in particular here placer deposits they are more placers are formed due to more mechanical weathering. For example, if you see here suppose we have a vein structure. Suppose for example it is a gold vein say and this is the slope face of this hill and finally you see this weathering due to weathering mechanical concentration is there here.

And finally it is going down slope and down slope and it is stream placer. At the stream bed it is getting deposited. This is a stream placer. So in terraces we are getting this type of placers. So mechanical concentration due to wearing of lighter minerals the heavies remains there that is

called placer deposits and mostly the heavies the metals they are concentrated in placer deposits. Similarly, in the Indian east coast if you confine ourselves it is the Bay of Bengal continuously hitting this eastern boundary of Indian subcontinent.

And this side is the Eastern ghat, Eastern ghat it is mostly composed of khondalites, charnockites group of rocks. So from here the heavies like garnet, the monazites they are getting removed and they are concentrated along the coast zone of the India and this is one photographs which is showing the concentration of the placer minerals along the coastal zone. So placer mineral deposit in particular that is very much important in terms of mineral deposit due to weathering.

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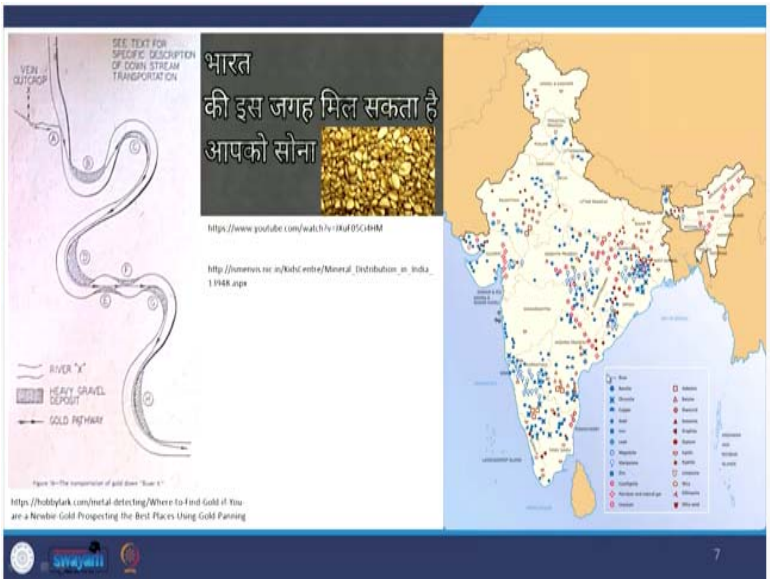

Similarly, in river also different parts that means these meanders the inner curves of the meanders they are also responsible for heavy mineral deposit and particularly gold deposit 2 rivers I am giving you this example one is called the Markanda river in Haryana, another river is the Subarnarekha from Jharkhand in Odisha and there are many rivers in southern peninsula also. Here this inner curves which mostly dominated by deposition.

Here heavy placers heavy minerals like gold they are deposited. In Markanda river people are engaged in gold grain collection. Similarly, in Subarnarekha people are engaged in gold sand collection and that is their daily business. So that means I want to say placer mineral deposit is

mostly due to weathering. So one of this wealth which is adding to the national economy. Here 2 photographs from Visakapattanam coast.

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If you see here this sand the coastal sand this one the coastal sand some of black and white portions are there and it is by this wind ripple and this black portions they are representing the heavies mostly the monazites and we have beach placer deposit at Gopalpur east coast of India similarly in western coast, we have Kerala.

So we have these placer deposits which are the thorium monazite which is main source of thorium in nuclear mission in India. So this is due to the product of weathering, had weathering not been there this type of deposit might have not been occur in eastern coast of India.

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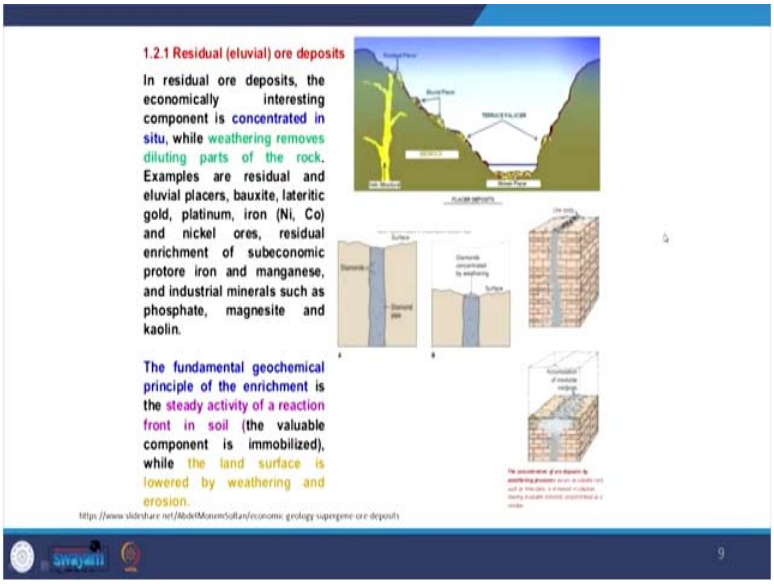

Then resident eluvial ore deposit alluvial, eluvial, diluvial it is one part this terminology is mostly found in these economic geology term secondary mineral enrichment. Here in residual ore deposit the economically interesting component is concentrated in situ while weathering removes diluting part of this rocks. That means its residual concentration residues the heavies the remains at their place.

However, the lights they are removed. Example of residual concentration is the bauxite, lateritic soil, platinum, iron ore, nickel these type of deposits mostly that the residual concentration. The fundamental geochemical principle of enrichment is that steady activity of reaction front in the soil. So that is another type of weathering which is mostly responsible for the residual concentration.

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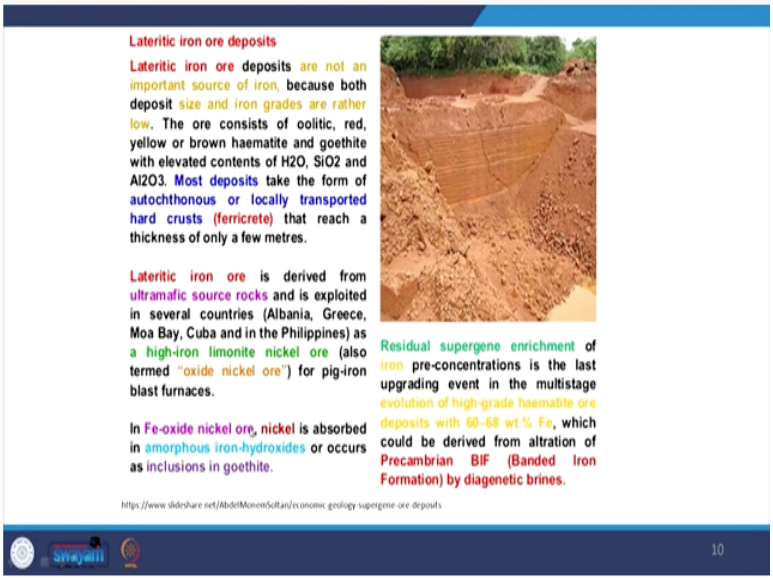

Here lateritic iron ore deposit or it is an bauxite deposit in Easternghat, bauxite deposit in Deccan Basalt both are in example of these residual weathering or the residual concentration where these residual minerals are the least resistant minerals are removed and most resistant minerals they remain they are in situ.

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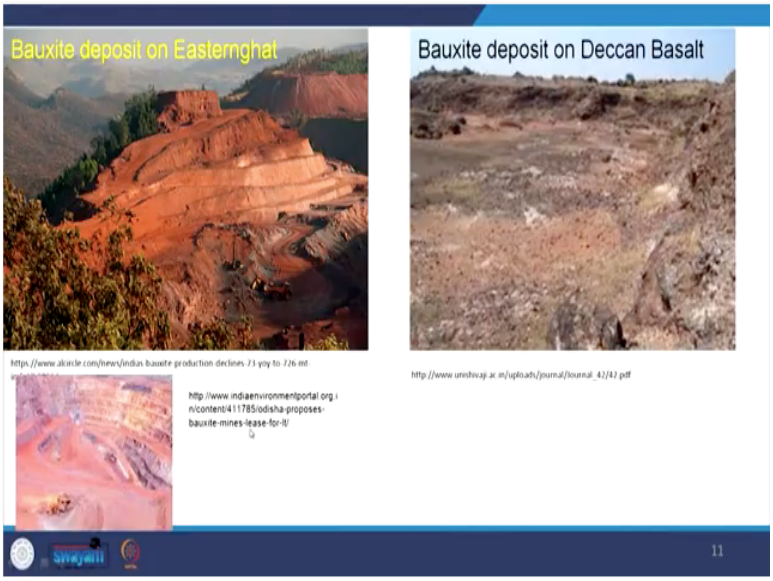

Here some of these photographs one is bauxite deposit in the Easternghat, bauxite deposit in the Deccan Basalt both are the example of residual weathering or residual concentration.

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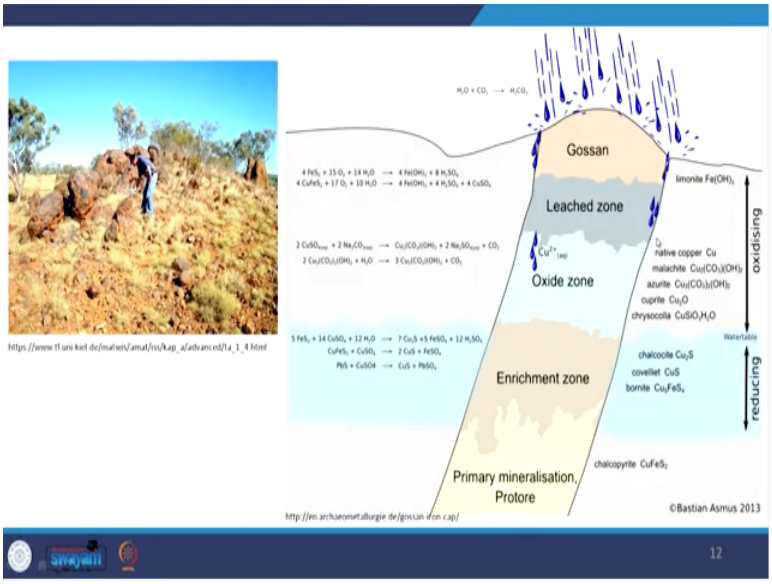

Then weathering which is found in the chemical weathering which is mostly the indicator of the gossan zone and mostly indicator of this sulphide mineralization is also another example of weathering. Gossan you know gossan is a group of rocks characterized by chemical weathering oxidized zone, chemical weathering limonite formation, iron oxide formation. If you see these photographs this is the characteristics color of gossan.

Gossan is a group of rock it is a signboard which says what lies beneath. So the shape of this gossan, the shape of the box for structure, the shape of this cavity, the color of this gossan that is the product of chemical weathering. So that indicates what mineral lies beneath? There are many mineral deposits in India not only in India in world that has been discovered due to the help of this gossans.

If you see this profile in the gossan firstly due to raining due to chemical weathering their oxidation takes place here and some of this mineral which are not stable in this geochemical condition. They getting dissolved and going down with water percolating groundwater and finally once they reached the oxidized zone and they go up to the enriched zone here sulphide mineralization takes place.

And in the oxide zone some of the minerals getting oxidized and these are the leached zone that means here the residual concentration is there and here concentration is chemical concentration

is there. This is enrichment zone here most of the sulphide deposit like copper sulphide we have Rampura Agucha, we have Khetri these copper deposits are due to this type of chemical enrichment or this is due to this type sulfide mineralization is due to this chemical weathering. So mechanical weathering and chemical weathering both are responsible for larger mineral deposits.

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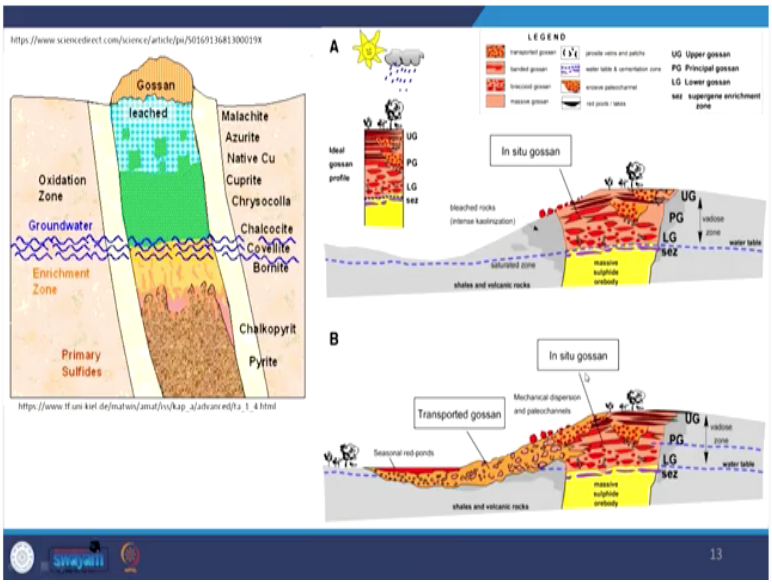

And some of these figures it is showing the gossans and here suppose we have gossans. There are 2 types one is called in situ gossan and other is called transported gossan. Both in situ gossan and transported gossan they says what type of mineral occurrence or what type of mineral deposit may in the side of this geological localities. For example, if you see in situ gossan here in situ gossan depending upon the gossan composition, depending upon their box work structure we can say what type of sulphide minerals are lying beneath.

Similarly, this gossans they are eroded mechanically and transported downhill and due to reaction of this water reaction with the water near about waters seasonal points this become red in color. So by looking the red color ponds in an area we can guess there is some where there is a gossan inside and side this area and geological exploration should continue to hit this gossan zone. Once the gossan zone is targeted and once it gossan zone is found we can say the mineral deposit which is lying beneath by analysing the gossan characteristics.

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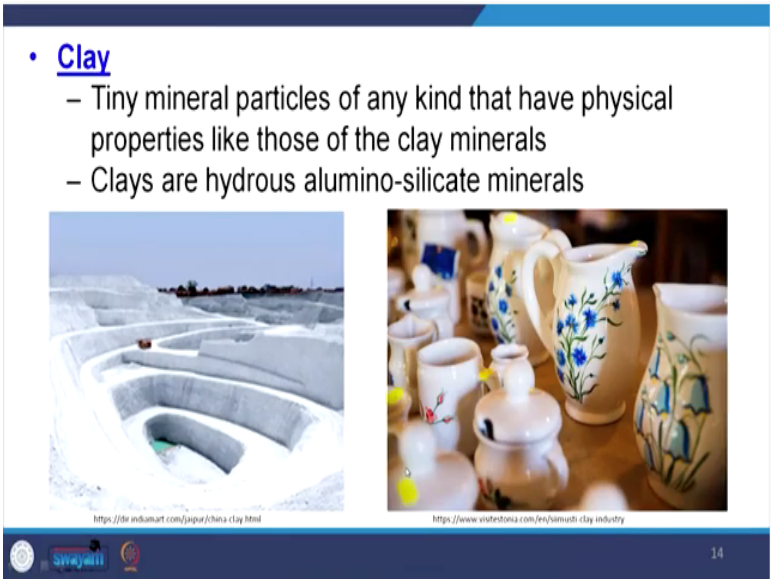

Then another very important product is clay. Clay is a product of chemical weathering. So if you compare this Archean geology or Archean environments you see when there was no sedimentary rocks. There is a granitic granodiorites exposed to the surface. There are pools and pools filled with water. The water was in constant interaction with the beneath the rocks.

So there was chemical exchange and from the chemical exchange there are clays were deposited and those clays which are now being used to define such type of structures like such type of potteries and personalized basins like that. So clay is a product kaolinite mostly the kaolinite is the product of chemical weathering. Tiny mineral particles of any kind that have physical properties like those of clay minerals.

Clay are hydro-aluminium silicates hydrous aluminium silicate and those clays are playing very important role for decorative material high resistant minerals like high temperature resistant mineral or temperature resistant equipment apparatus like this.

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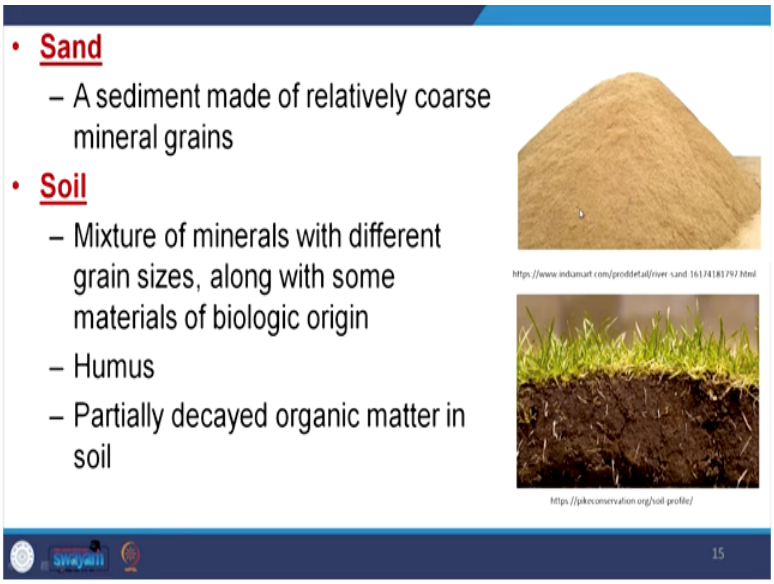

Then sand, sand is another product it is a very important product for our sustainable development for development purpose and for many industries they use sand for their purpose we will discuss here. And soil it is the most important product of weathering had soil not been there, there would not have any cultivation or crops. So soil is a product of chemical, physical and biological weathering.

And mixture of mineral with different grain size along with some material of biological origin that is humus partly decayed organic matter in the soil. So that means soil is the most important product to sustain life on the earth crusts and sand it is used in different industries if you see here the use of sand there are number of lists.

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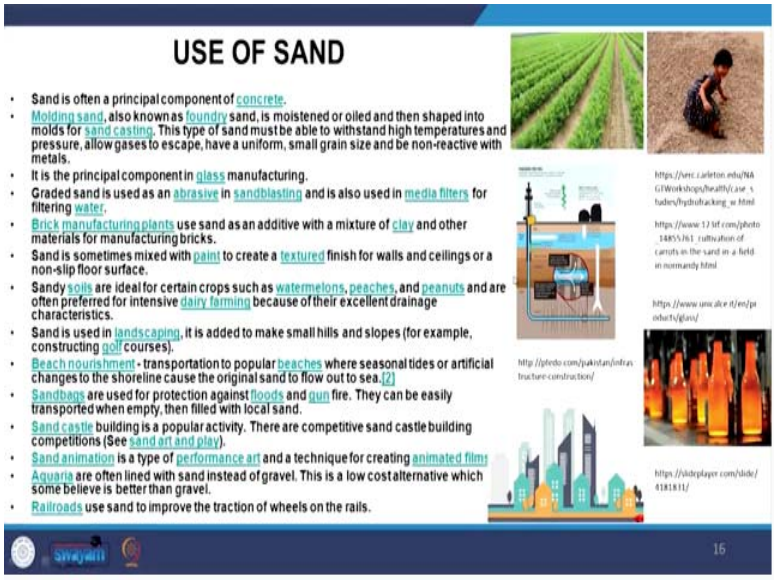

So starting from your childhood place, then cultivation, then it is in the oil industries oil exploration industry, it is in the glass industry, then infrastructure development everywhere we are using sand for this purpose. So that means I want to summarize it here that weathering not on studying weathering is not only important. How it produces different valuable minerals for us? So weathering product is very much important rather than and to analyze this product we must analysing the process.

So weathering process to understand the weathering process is important what type of climate that will promote what type of weathering and if we were expecting some type of product we must concentrate ourself in what type of climate? What type of rock types is there? And what would be this product? So that is why product and process relationship to understanding the product and process relationship is very much important in terms of weathering.

And had weathering not been there we would not have getting these type of important valuable mineral deposits like copper deposits, like this placer deposits, like gold deposits, like and some other mineral deposits like bauxite deposit, iron ore deposits like that. Similarly, had weathering not been there, there would not have been a soil and without soil we do not have a cultivation, we do not have crops and we do not have cultivation crops we do not have life.

So that means I want to say similarly in chemical weathering if we say if you remember our precambrians when we were talking about these chemical weathering versus physical weathering that is the chemical weathering though it plays limited role or relatively limited role as compared to physical weathering. But its role to maintaining the oxygen level in the Earth's atmosphere is very much important.

So by providing us food, by providing of water, by providing us this cultivation the food crops this weathering and providing us minerals this weathering plays important role. So that is why weathering should be taken seriously it irrespective of its type and it is mostly we should concentrate then what type of geological or what type of chemical system is involved the formation of this product from a rock. So this is all about weathering. I think we will meet in the next class. Thank you very much for your concentration. Thank you.