Earth Sciences for Civil Engineering
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Module 2
Lecture No 11
Rock types and their Properties (Part-5)

Welcome back. So last lecture, we were talking about the different categories of clastic rocks. So rudaceous, arenaceous and argillaceous.

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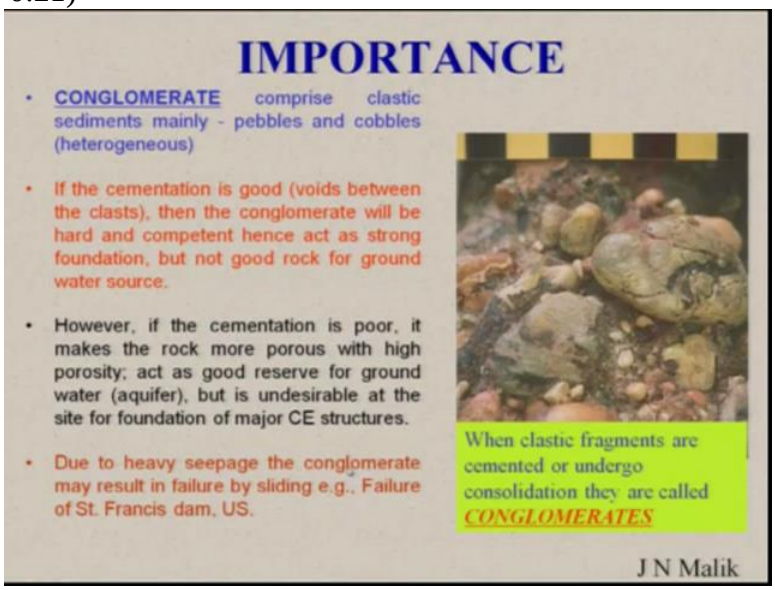

And then were talking about the common this is one of the examples of the rudaceous rocks. What is the importance of this in day-to-day environment what we look at? So conglomerate which is comprised of clastic sediments mainly pebbles and cobble along with the ground mass. So if cementation is good okay so void that is the void between the glass is the conglomerate will be hard and compact or competent.

Hence act as a strong foundation. So this is important for sea particularly but not good water for the groundwater source okay. So this is one of the important part. However is the cementation is poor okay, it makes the rock more porous with high porosity. So in that sense, it is a good reservoir for groundwater or it is a good aquifer but is undesirable at the site for the foundation of major CE structures okay.

So when you come across the conglomerate you need to know that what type of cement it has okay. If it is competent or good cement okay, then you can use that as or indicate that this is good for the foundation but if it is the poor cementation okay and which breaks easily then it is not good for the foundation okay. So due to heavy seepage, the conglomerate may result into failure by sliding and one of the example for failure of St Francis Dam in US was the conglomerate was poorly cemented.

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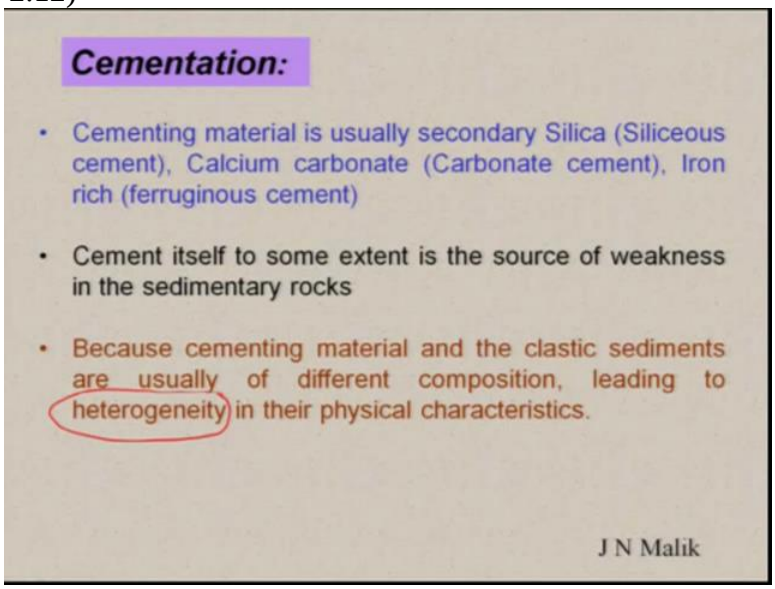

Now cementation particularly if you take, that material is usually the secondary silica okay. And siliceous cement if you are having calcium carbonate, this is the carbonate cement or it is ferro-magnesium cement, iron rich. So most harder if you look at, you will find that if it is having ferro-magnesium cement okay. Cement itself to some extent is the source of weakness to the rock size we have discussed in the previous slide okay.

Because the cementation material and the clastic sediments are usually of different composition. So you will have the clasts are different composition and the cement is will be of different composition. So that is a heterogeneity which we will have okay. Leading into the heterogeneity of their physical characteristics okay. So this is one important part of the cement which you can remember. Either it is siliceous, carbonate rich, you are having the iron rich okay.

So because of this, such rocks will not behave homogeneously under stress okay. So this is a very important part. When we are talking, we will talk about the sheer strength and all that okay.

So since they are comprised of different material, so we will have an sort of a heterogeneity, we will have the heterogeneity of the material within that Rock, clastic rock.

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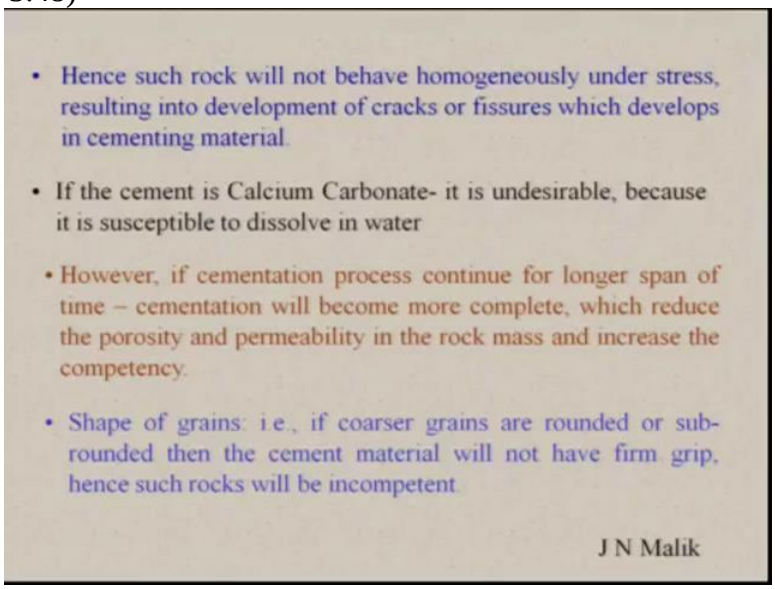

Hence, they will behave differently under the stress okay resulting into the development of cracks and fissures. So if you are having softer material which is either the rock clast okay or the fragment which is of the minerals which are less harder okay, then it will break early as compared to the ground mass okay. So because the conglomerates will have the heterogeneous material, the rock will not behave homogeneously under stress, resulting into the development of cracks or fissures which develops in the cementing material okay.

So either the cementing material will crack or the rock fragments will crack okay. So if the cement is calcium carbonate for example, it is undesirable because it is susceptible to dissolve in water okay. Calcium carbonate will dissolve in water. So it is not so if you find the material or the conglomerate, cementation material calcium carbonate you should avoid okay. However, if the cement process cementation process continues for a longer span of time, cementation will become more complete which reduces the porosity and permeability in the rock mass and increases the competency.

That is the strength of the rock will increase. So if the process of cementation and compaction will last for longer period, then you will have better rock stress okay. Shape of the grains are also important That is if the grain size, coarser grains are rounded or surrounded, then this cementing

material will not have firm grip okay. So if you are having Breccias as compared to the conglomerate, then the Breccias are better because they will have angular fragments okay within that okay.

So this is the reason why they will have the incompetentness okay. So most of the coarser gravels which are, the coarser grains which are rounded in shape will result into the incompetent rocks. So this is another part in terms of the shape. So once we have, previously we have talked about the chemical composition of the of the matrix what we are having or the cementing material. And then we are having the shape of the grain size okay.

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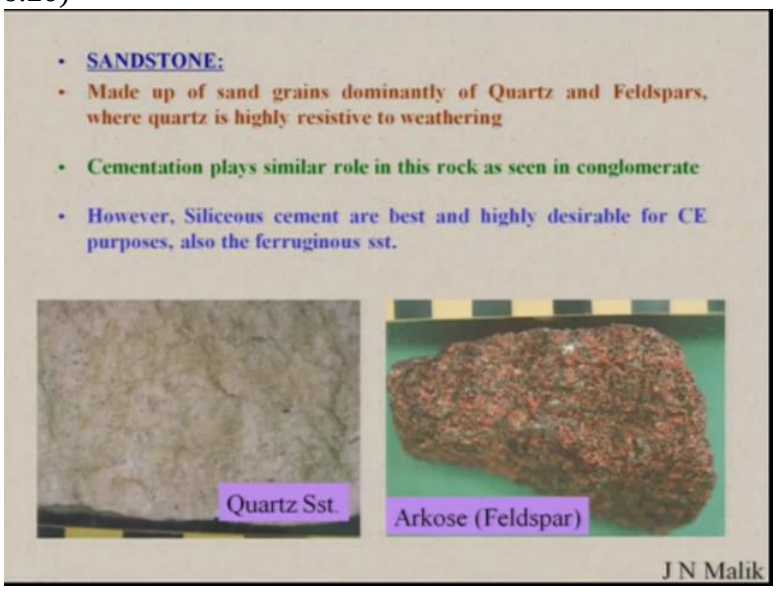

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Quartz sandstone and this is arkose feldspar rich sandstone we are having. So made up of **grain** sand grains dominantly of quartz and feldspar that the quartz is highly resistive to weathering. So cementation plays similar role in this rock as seen in conglomerate. However siliceous cement are best and highly desirable for CE purposes. Also the ferro-magnesium sandstone okay.

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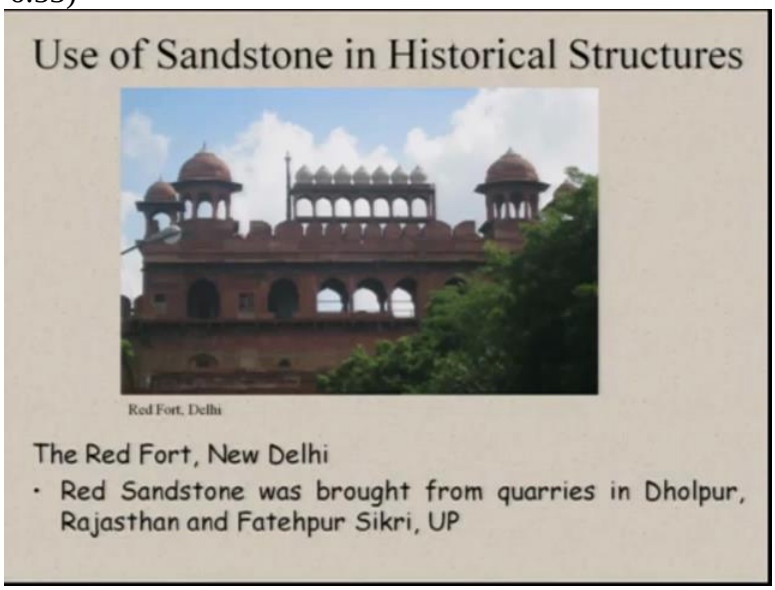

Use of sandstone and historical structures okay. So if you look around and just try to see that different monuments, historical structures india itself, you will find that most of the historical structures in Delhi and around are made up of sandstone okay. And those are again the Ferrogenous sandstone. So we are having mostly this type of material.

So this is in red Fort which is in New Delhi. Red sandstone was been brought from the quarries of Dholpur in Rajasthan and Fatehpur Sikri. So this is the example of the sandstone and the structure which was been constructed from sandstone.

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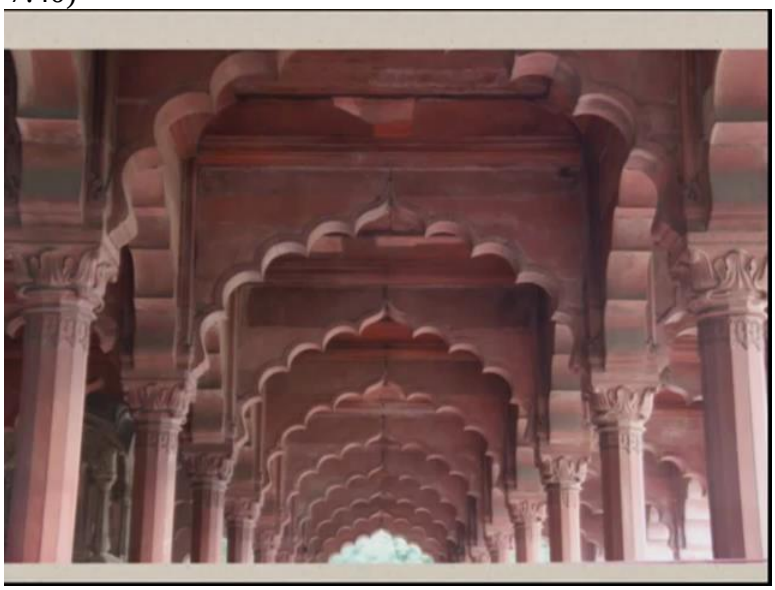

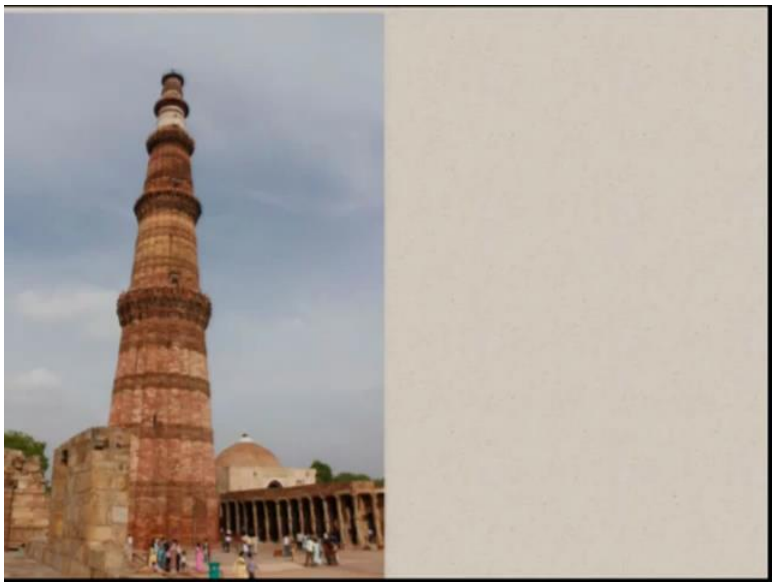

This is inside that region. Okay we are having again you can see beautiful carving is in Ferrogenous sandstone. Again, Qutub Minar. Of course, this part is having marble but rest of the storeys are having all sandstone okay.

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Then we are having the famous area in Fatehpur Sikri and along with the Bulund Darwaza. This again is made up of sandstone here okay.

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Then this is the Agra Fort.

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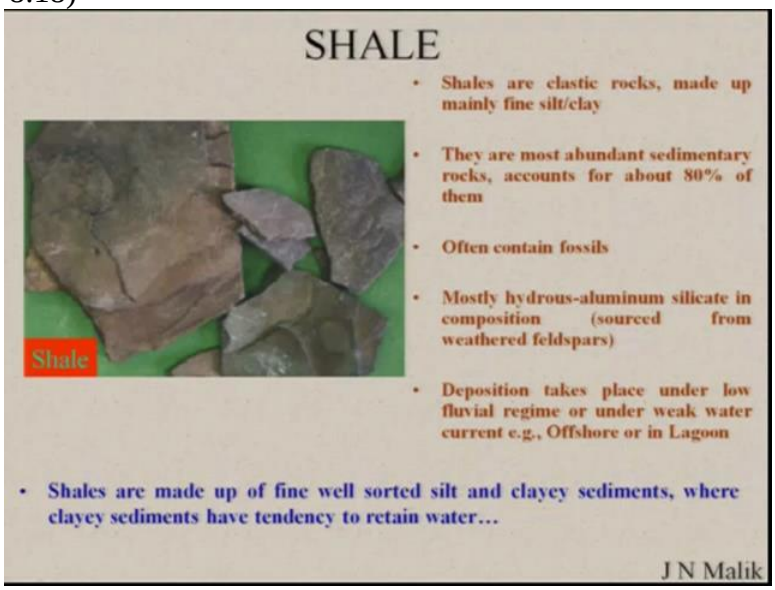

Now coming to the another finer size sedimentary rocks. So we have seen conglomerate, we have talked about sandstone, we have talked about the now we will talk about the finer one which are shales okay. And please remember that borders the importance of cementing material? What is the importance of these shape of the clastic grains okay or the clast? Now, shales are mostly fine-grains.

So they are they mainly comprise of silt or clay. They are most abundant sedimentary rocks, account for about 80% of them okay. Often contains fossils. Mostly hydrous aluminium silicate in composition sourced from weathered feldspar okay. So deposition takes place under fluvial regime or low fluvial conditions or under weak water currents offshore or under lagoonal environment also mostly seen okay.

Shales are made up of fine, well sorted silt and clayey sediments where this clayey sediments have tendency to retain water okay. So in the beginning when they were talking about the minerals okay, clay minerals have sheet structures. And sheet structures are having capability of holding water okay.

So they they have the capability of retaining water which can result into the weakening of the this type of rocks that is particularly shale okay. So if you are coming across shale, it is again, it is not very good to put any civil structure on that okay because it can hold water and result into the slippage along the plane's okay..

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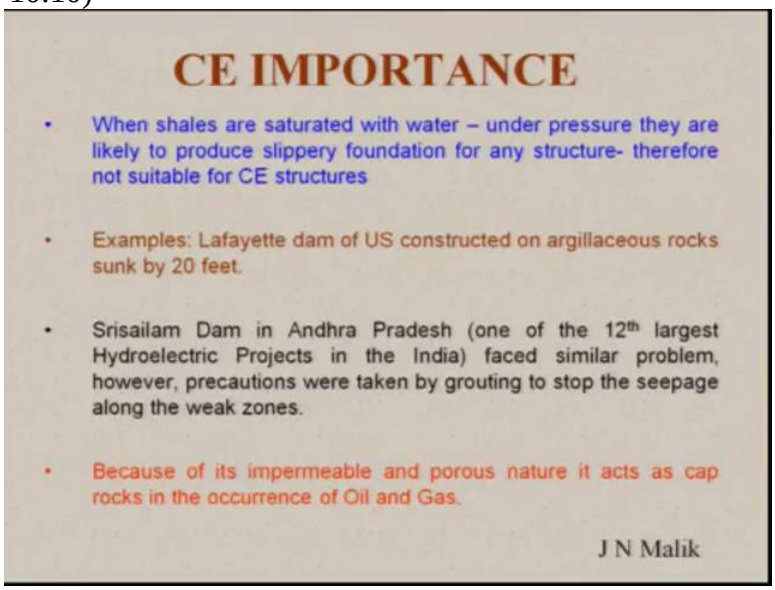

So CE importance if you take in terms of when shales are saturated with water, under pressure they are likely to produce slippery foundation for any structure. Therefore not suitable for putting any civil structures on that okay. Example, Lafayette time of US constructed on the argillaceous rock sunk by almost 20 feet okay. So this was the mistake which was been done in US.

Also india Srisailam dam in Andhra Pradesh, so one of the 12^{th} largest hydroelectric project india faced similar problem. However, precautions were taken by grouting and stopping the seepage but had a problem because of the it had an foundation which was made up of shales okay. Then because of that is a shale, because of its impermeable and porous nature, it acts as an cap rock for the occurrence of oil and gas.

So in a way, it is good for the fuel minerals but it is not good for the foundations okay.

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So evaporatic rocks if you look at then these rocks are formed within depositional basins from chemical substances dissolved in seawater or lake water okay. So one is gypsum. Again, they are evaporites mostly seen in the arid region or the semiarid regions. And then we are having the halite okay.

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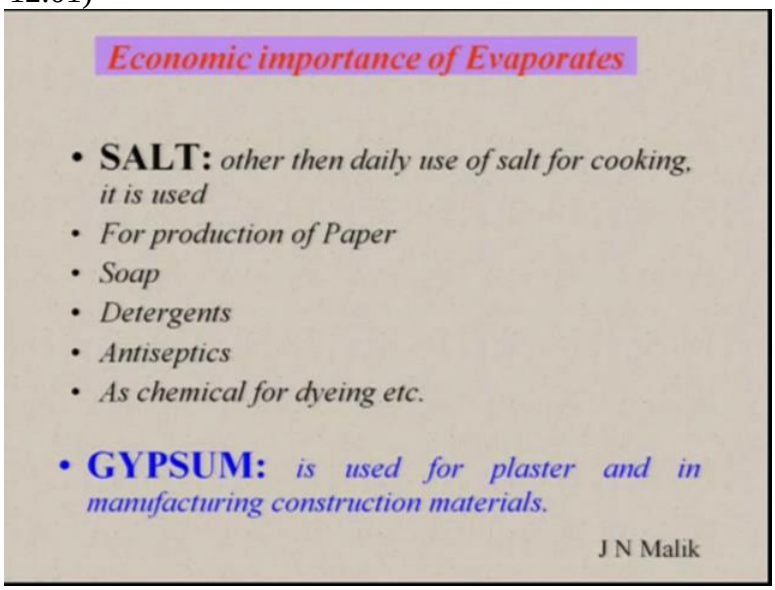

Economic importance of the evaporates. Salt of course, other than daily use of the salt cooking, we use in for cooking and for and other than that, we are having for the production of paper. Then we are having in soap, detergents, antiseptics okay, as chemical for dying industries. So that some particularly is used for plaster and in manufacturing construction material. So we are

having the economic importance for this minerals okay for this rock okay, evaporitic rocks mainly the salt and gypsum.

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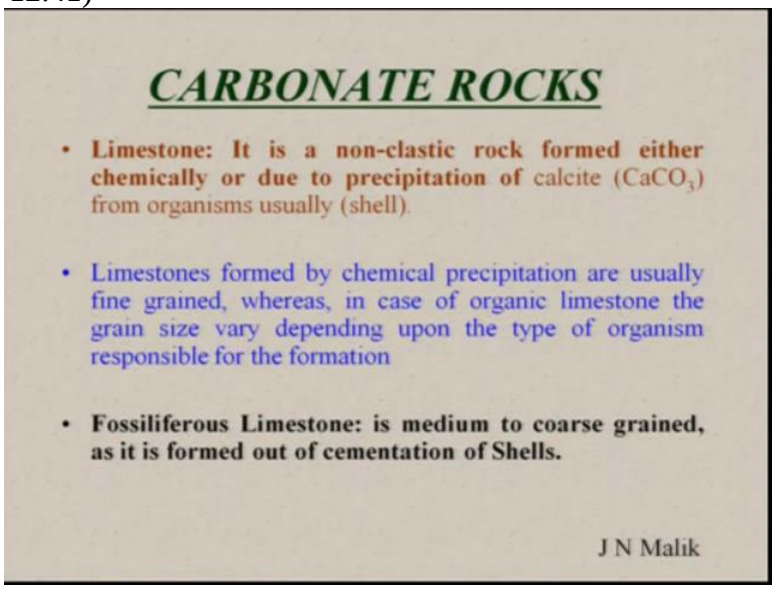

Then we are having the carbonate rocks. So limestone, it is again a non-clastic rock formed either chemically or due to precipitation okay of calcite. Or from the organic material or we can say the organisms usually the shales okay. So limestone formed by chemical precipitation are usually fine-grain. Whereas which are formed which comprises the organisms are comparatively coarser grains okay.

So whereas in the case of organic limestone, the grain size varies depending upon the type of organisms responsible for the formation. So either the shales are larger size or the smaller size, depending on that it will be the grain size will be seen okay. But most of the, because of the precipitation if you see the limestone, they are fine grains okay.

They are also termed as fossil ferrous limestone. They are medium to coarse-grain nature. And as it forms part of the cementation of the shales, mostly the shales are responsible.

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This is an example of the fine grain limestone and here you are having coarser grain limestone okay, fossili ferrous limestone okay. So you can see the shales here, the size of the shales here okay.

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And these are all all medium size shales. But most of the, here you are having larger shales and then you are having a round mass whereas here mostly you see is the shaly material or broken shales okay.

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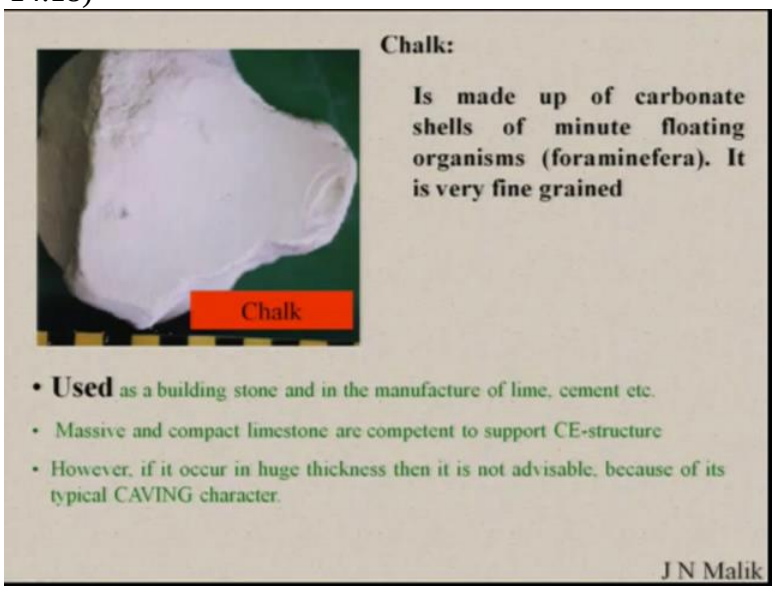

Then we have chalk with again fine-grain rock sedimentary rock. It is made up of carbonate shales and mostly the very fine or small size organisms you can say which are termed as foraminifera or very fine grain. So used as a building stone and in manufacturing of lime and cement. Massive, they are massive and compact in nature okay. So they are competent to support the CE structures.

However if it occurs in huge thickness, then it is not advisable because the typical have the caving characteristics okay. Subsolution activity will result into the caving effect. Hence in most of the places, if you are having very thick deposit, they are not advisable for the putting any civil structure on that okay. Because it will result into the subsidence of the surface of the because of the caving from below.

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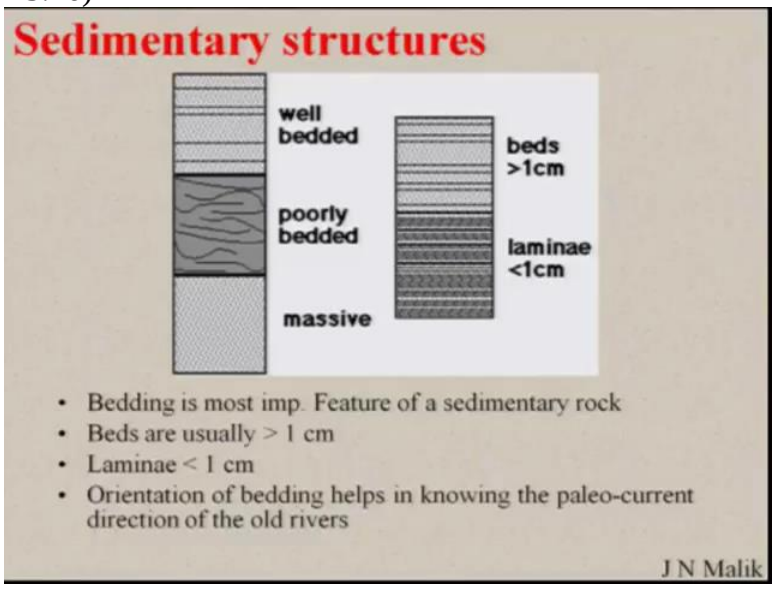

Now coming to these structures okay. So we have looked at the composition. Then we have been talking about the grain size. We were talking about the shape. Now we will talk about the sedimentary structures mainly okay. Now looking at the sedimentary structures also, one can also talk about that the depositional environment. Also the energy conditions and all that okay.

Now before getting into the sedimentary structures, we will just look at the that we have **the** either structure less or they are having poor bedding or they are well bedded. So there is no structure, so very calm environment. So deposition has taken place. So bedding place is the most important feature of the sedimentary rocks okay.

And the beds which are having usually size greater than 1 cm are termed as beds okay or the layers which are having the size greater than, so thickness is greater than 1 cm, they are termed as beds. And the layers which are having the size or thickness less than 1 cm are termed as laminae. So orientation of the bedding helps in knowing the paleo currents also.

So these are horizontally stultified. So they are deposited in a very calm environment. But if you and mostly these type of structures are associated with the likostrine or the lake environment where you are having a basin and then a very calm deposition is taking place.

But if you are having a floor deposit, then this orientation or the angularity of this will change. That is the attitude of the beds will change. They will have different angles okay.

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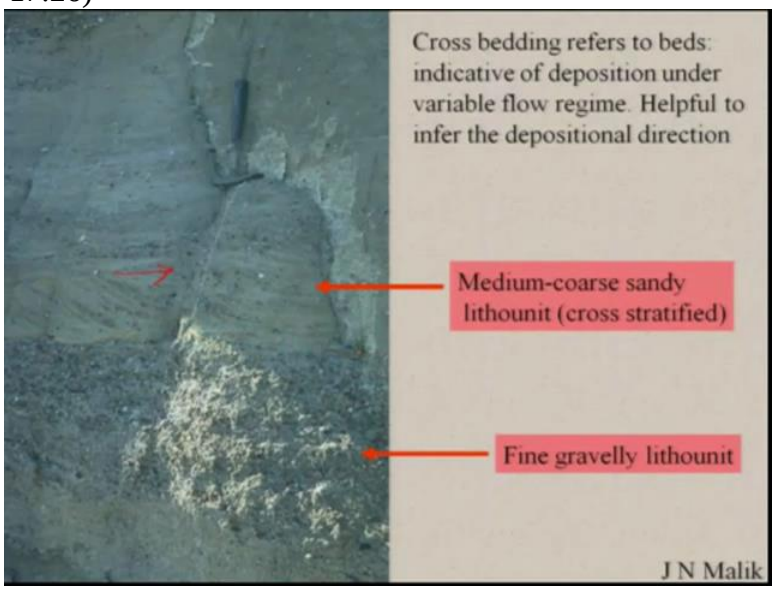

So cross bedding refers to beds okay indicating the deposition under variable flow regime okay. And it helps in identifying the depositional direction, in which direction they were deposited? So for example, we are having, these are the (())(17:44) here. So we are having this inclination here. So we can say that deposition was in, the deposition took place in this direction okay. So the flow was in this direction.

Similarly here we are having fine grain lithofaces. And then we are having the medium to coarse grain lithofaces. This also helps in identifying or understanding so this is the contact here which is graded gradational contact. We cannot say that as a very short one. But we can, so we have one contact here we can say.

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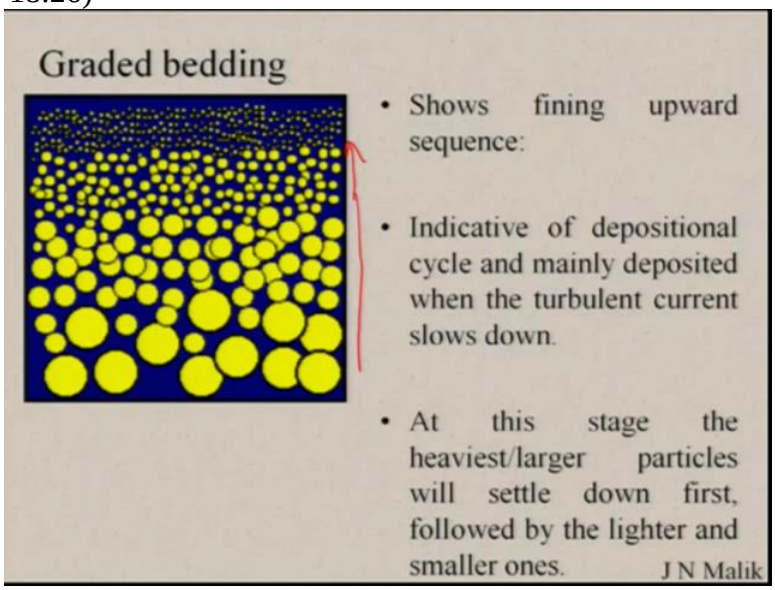

So graded bedding if we take, what we see is that we will have the coarser deposits at the bottom and then we have the finer deposits at the top okay which is what we call the fining upward sequence okay. And this againdicates that the deposition whether it was fast or maybe we can say it was it was with high-energy condition and slowly it reduced or lost its turbulence okay. So when started with, the deposition was turbulent and then slowed down okay.

Grain size varies from bottom to top okay. So at this stage, the heaviest or the largest particles will settle down fast followed by the lighter ones and the smaller ones on the surface okay.

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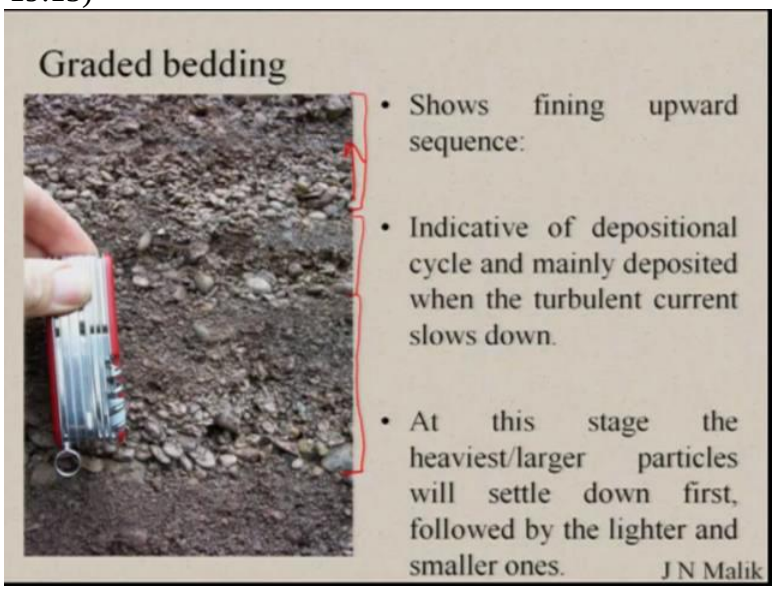

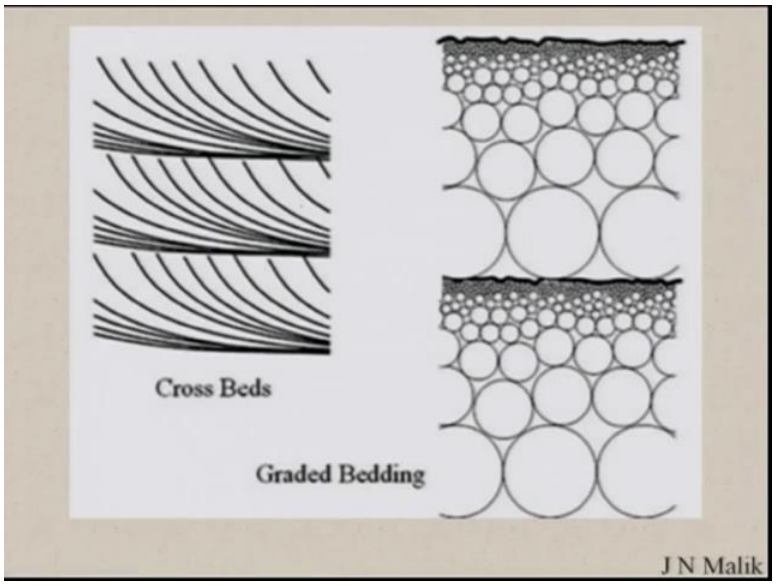

So we are having the graded sequence here okay. So if you look at this part, then we have different cycles here okay. So one is coarser, then becomes finer. So this is one we have and then coarser and finer we are having another cycle and then we are having this one is 3rd here okay. So we have at least 3 sequence of deposition in this one okay.

So flow condition starts with the with the turbulent one slowed down and then turbulent one slowed down. So we are having different cycles here which also you can identify if you understand the graded sequence and their nature okay. So this is an example of the graded sequence.

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And as I was talking about that the horizontal laminations okay will help you in identifying in that what was the environment in which they were been deposited. So this which is we say that the rhythmic layer okay. So they are having very fine layers which are been seen and they are indicative of deposition under the lake environment.

So when you understand these deposits or try to date, you can also try to understand their deposition of sequence in this region. So this indicates a very calm environment under which they got deposited. They are termed as warfs.

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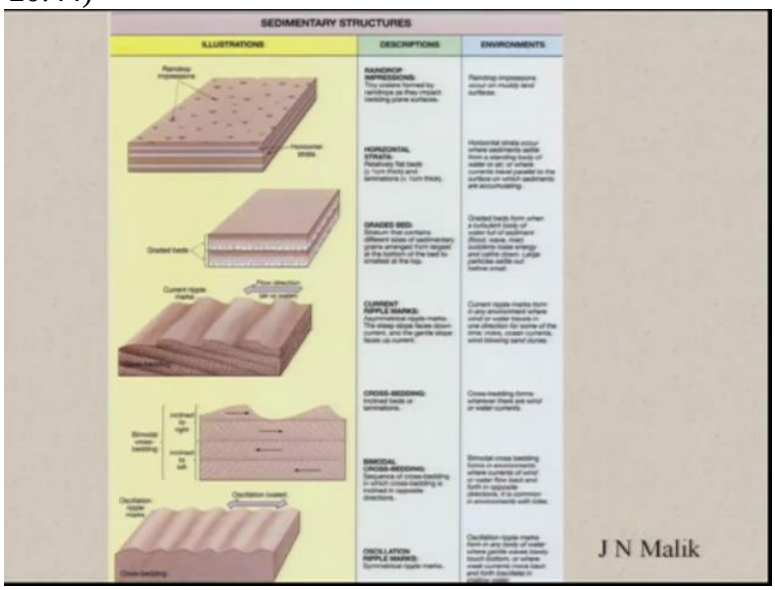

Then these are the illustrations which gives you an idea about the surface manifestation as well as the structures of different in these were formed in different sedimentary environments which are like for example, you are having horizontal status and then you are having graded beddings. We have already discussed. We have cross beddings which also helps you in identifying the flow directions okay.

So this will indicate again the flow direction here. Then we are having the cross beddings okay which are having the bimodal directions. So this also indicates that if you take this one okay and they are inclined, they are they are showing inclination here okay, so they got deposited here the flow direction again. So they are having different directions of the flow.

And mostly seen in the in the areas where you are having the bidirectional mode of deposition okay. So in the coastal region again, you will see these type of things and also in the where you are having the formation of sand dunes and all that okay. And the oscillations again, these type of ripple marks are formed where the oscillation of water is back and forth, mainly in tidal regions okay. So you will find this type of deposits.

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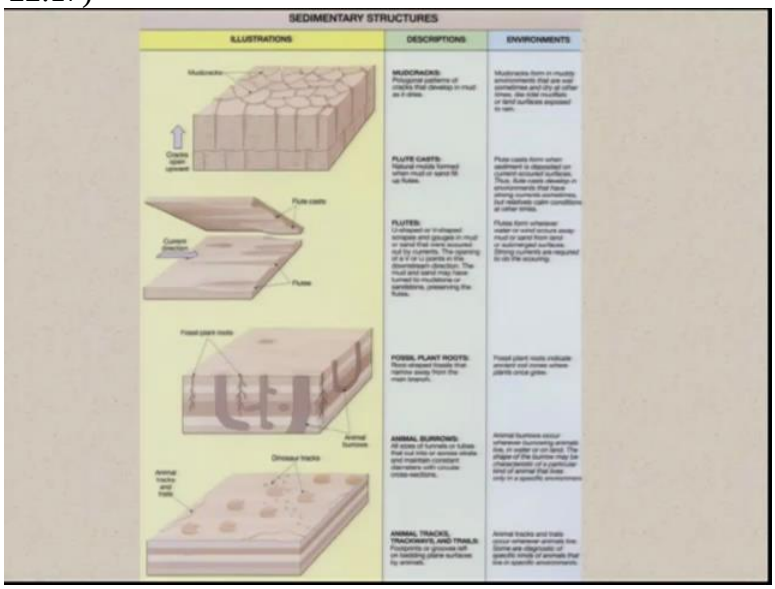

Similarly again, we are having more which you can go through which we have mud cracks okay on the surface. Then we are having footmarks. Then we are having the roots or maybe we are having the animal burrows and all that. Different type of burrows are there. And then we are having foot prints also which which usually get preserved on the surface are also been help to

identify the different types of environments and all that okay for the floras and faunas from that region.

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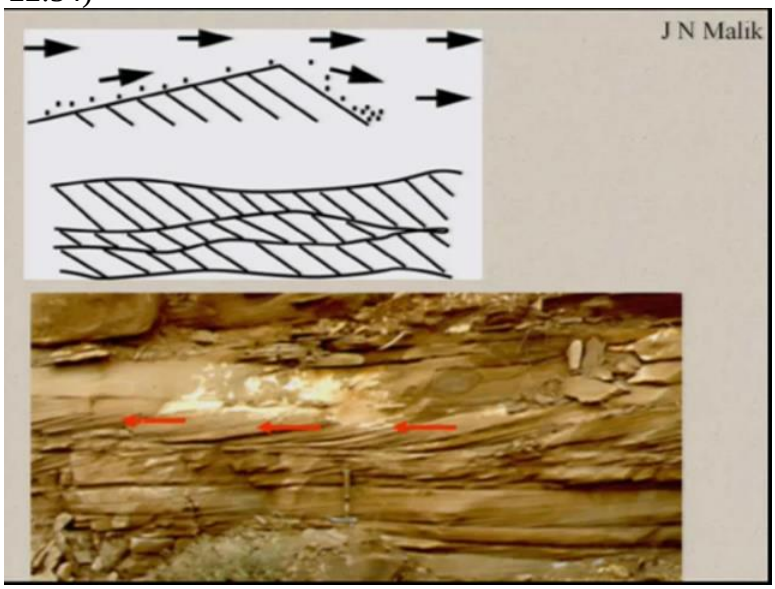

So, cross stratification, this is the direction of the flow if you are having the cross bedding here and with the direction of the flow you can talk about that how they were been deposited. So again, you can have the flow direction. These are the indications of the inclinations of the beds or the deposition. The direction will be in the opposite one okay.

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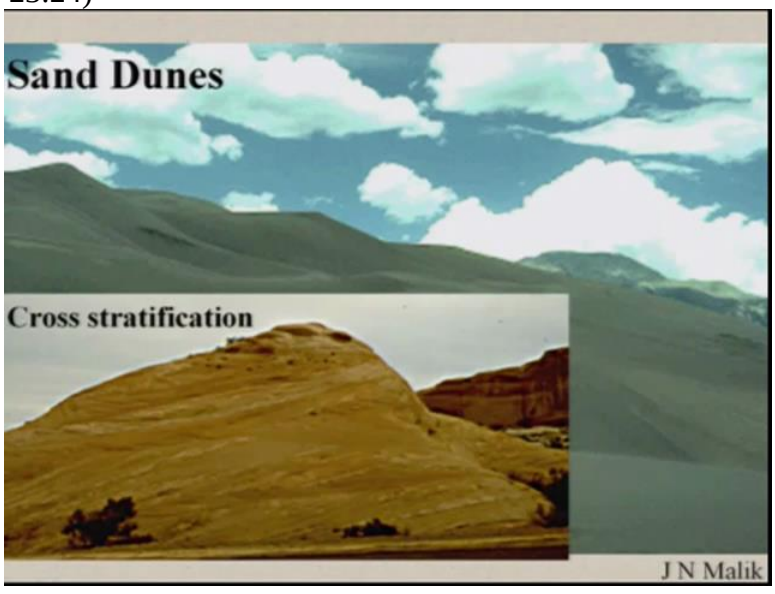

And then you are having sand dunes. So again, you can try to identify or understand the different depositional environment okay, how they were been deposited. So you can have large scale cross stratification in dunes also which can help you in understanding that how this dune was built up. Cross stratification, this we term as cross stratification. We are having cross cutting relationship between the different beds. See here okay.

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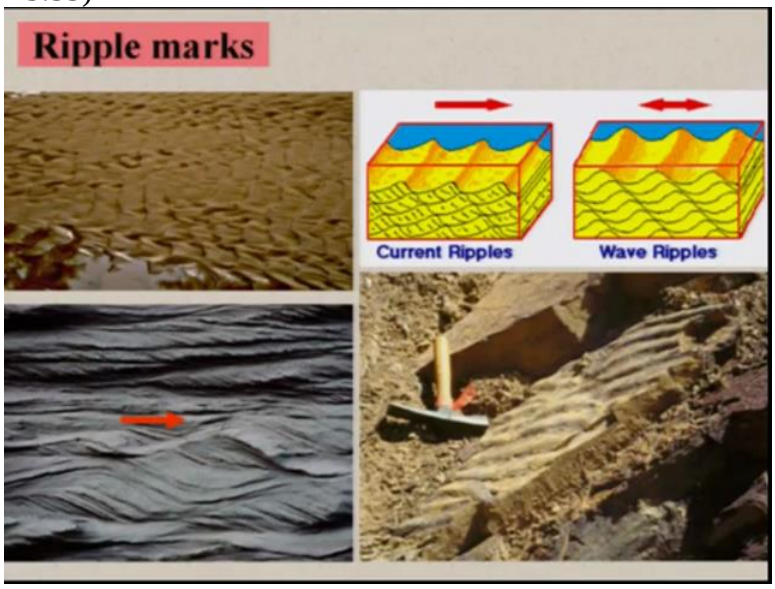

Then we are having ripple marks which again as I was talking about that they will indicate the depositional environment at different locations. So on the surface you will be able to see this type of features which are because of the oscillation of the water in the region okay. So in sections you will be able to see these type of deposits.

And in fossilised rocks, you may come across the features which you see in the present-day tidal environments okay which can tell you easily that this was the region which had an environment which was very much like in tidal environment which we see today.

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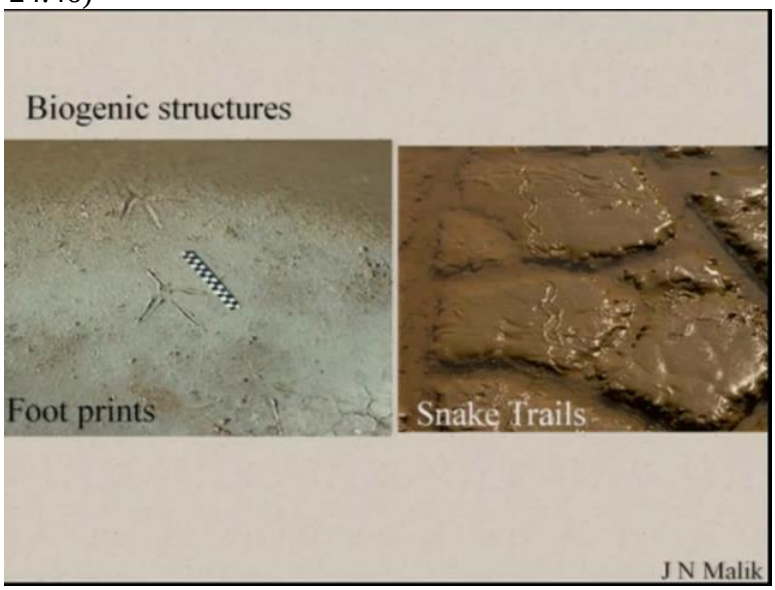

Then biogenic structures or the footprints can also help you in identifying the different what we can say floras and faunas in the region okay. So this is an example of the footprints okay. So this will talk about the, tell about the faunas floras you may have the leaf prints or maybe you can have the fossilised wood or something like that which can help you in identifying that okay.

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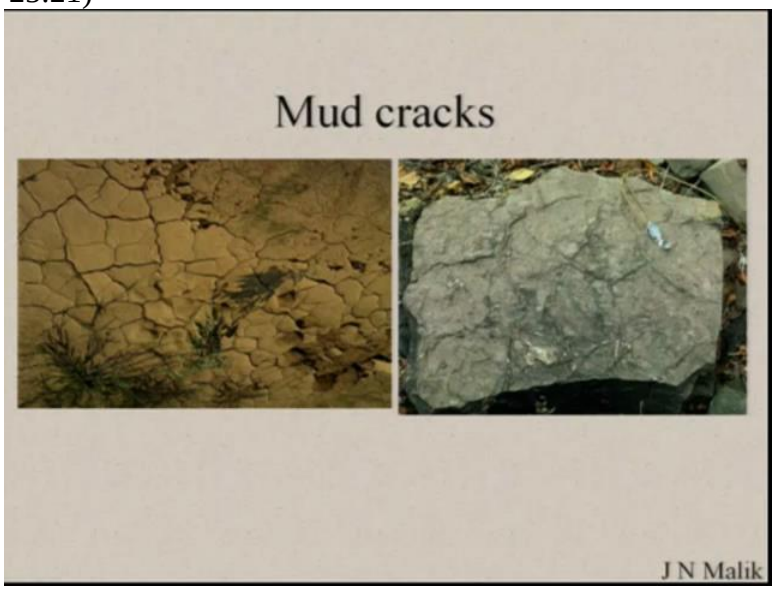

So mud cracks again the in the tidal environments you can find or the regions where you are having very dry spells. So you can also look at the different type of structures. So this is the present-day and these are the older ones which are found in the sedimentary rocks okay. So these

are all related to the sedimentary searches okay. I will stop here and we can start with the next lecture talking about the metamorphic rocks okay. Thank you so much.