Earth Sciences for Civil Engineering
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Module 2
Lecture No 10
Rock types and their Properties (Part-4)

So welcome back. During last lecture, we were talking about the pyroclastic force and as I told that these fragments okay depending on the size of the fragments, we say that okay either it is ash or it is the lapilis or it is bomb okay. And all are termed as the pyroclastic flow.

And so just to get started with, we will say that okay fine, this smallest size material which is coming out during the volcanic eruption, less than 4 mm its clay size are termed as ash.

And then we are having slightly larger which are lapilis and the biggest one which we talk as in bombs which are greater than 32mm okay. So pyroclastic texture or the rocks which are seen during the time of corruption which is coming out, we have the ground mass which is being termed as ash, okay the finer once. And then we are having the lapilis and all that okay.

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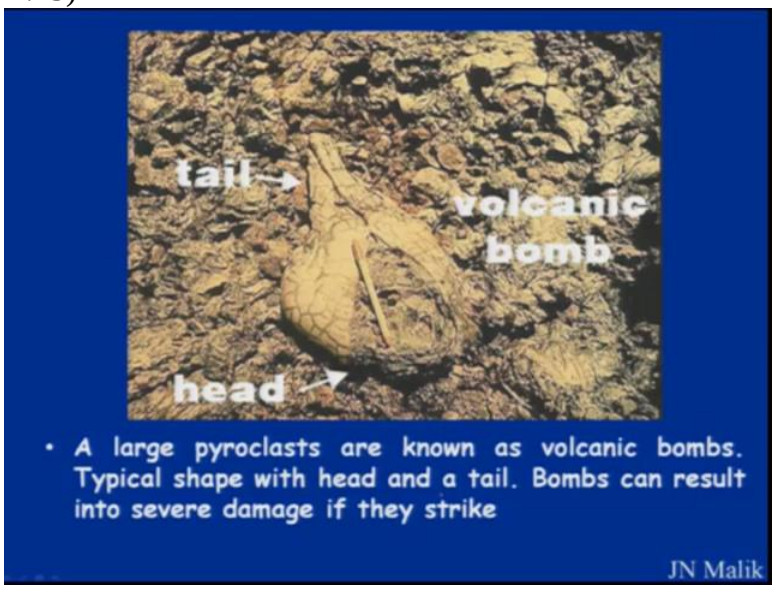

And the larger pyroclasts are known as volcanic bonds okay. And typical shape with an head and tail will be seen okay. And bomb can result into severe damage okay if they they they strike okay. So these are the very typical shape that we will see which is greater than 32mm and they have the tail and the head.

So definitely if this type of rock fragment is coming out and hitting somewhere, will result into the damage okay. So these are extremely dangerous in terms of the hazard okay.

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So we say that okay fine we are fortunate that we are not having such type of violent volcanoes along the Indian subduction zones okay we are having. So we do not have such volcanoes. Of course we have an active volcano along the Andaman arc which is known as barren island but it is not very violent as we have been talking about the different volcanoes around the world.

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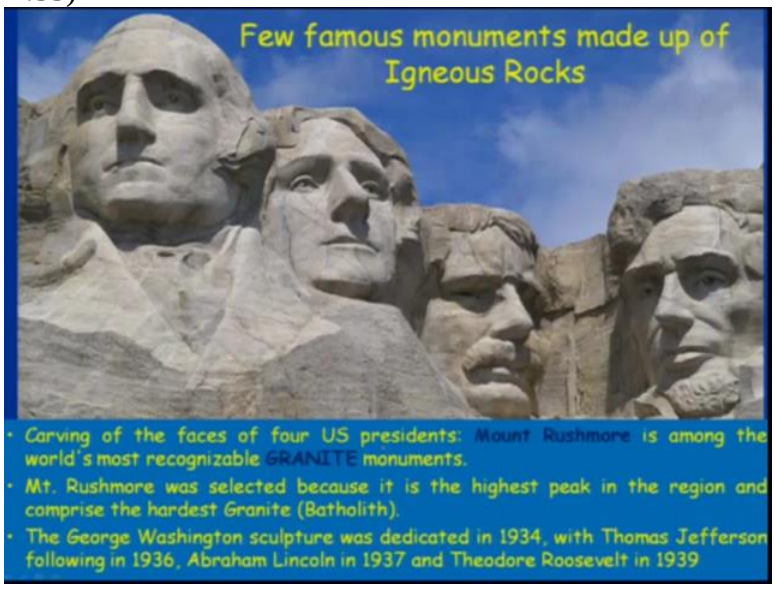

So few famous monuments. I just wanted to complete this lecture showings some of the monuments which have been made or which are located where or been built using the igneous

rocks mainly. So if you look at the famous monument, this one is famous Mount Rushmore which is in US which has been built on the granite okay. It is mostly the granite and the structure or the form of this is batholith okay.

So this is one of the batholith comprised of granite where this famous monument has been constructed. So the carving of the faces of 4 US Presidents here okay. Then we are having so you can read out this who are those actually.

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And then we are having Moai statues carved from bassalt okay. This is in Chile in South America.

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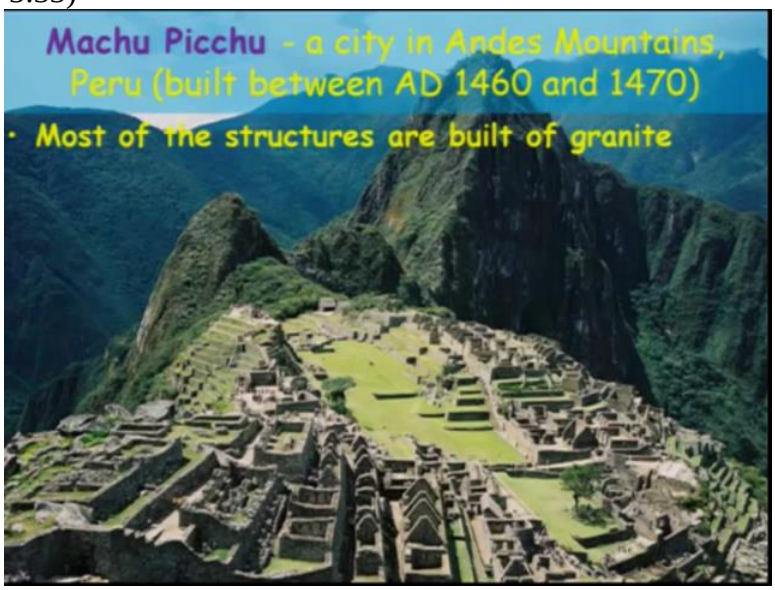

And then this is again Machu Picchu, a city of Andes Mountains, Peru which was built in A.D. 1460 and 1470 and mostly most of the structure has been comprised or built from granite.

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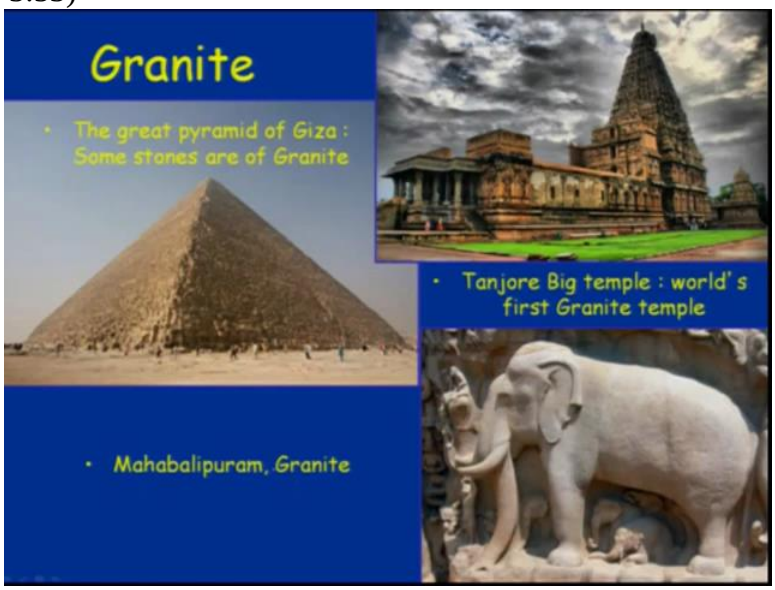

Then we are having the Tanjore Big Temple, world's 1st granite temple and then we are having pyramid. And then we are having Mahabalipuram the granite again the temple most of the carving was being done using granite here okay. So I end this year and then I will start with the another lecture of looking at the different type of sedimentary rocks mainly.

So we will see that how different type of sedimentary rocks are formed, where they are formed and how to identify these type of rocks okay. And as we have seen in terms of the igneous rocks okay.

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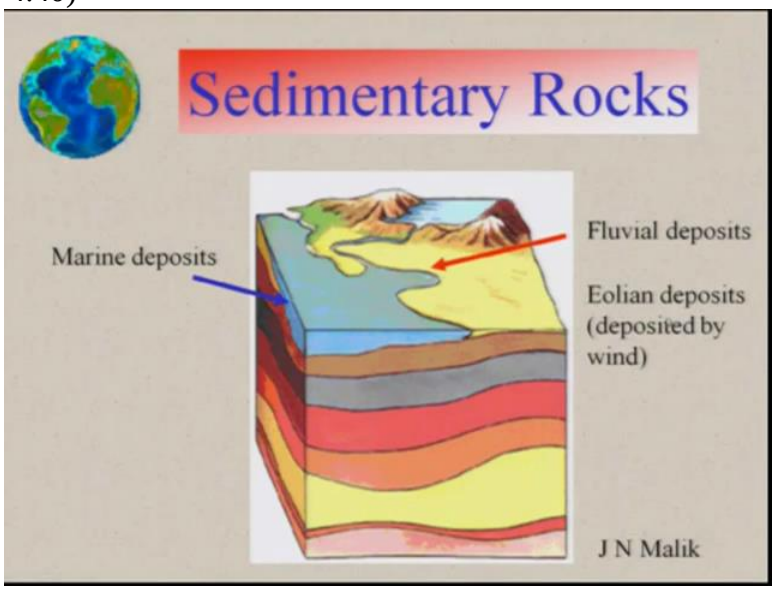

So the sedimentary rocks is most of the a very large area on the earths crust is occupied by the sedimentary rocks. So where we find the sedimentary rocks is mostly in the uplands, in the plain areas, that is alluvial plains and then in the ocean okay. And usually what we see is that the sedimentary rocks will be seen deposited in layers okay. So we are having older layers, younger layers and and then so on okay.

So we have the marine deposits, we have what we call fluvial deposits. So let us move ahead and see that what we are having and then of course we are also having the Eolian deposits. And then we can see we can talk about then there are glacial deposits also okay.

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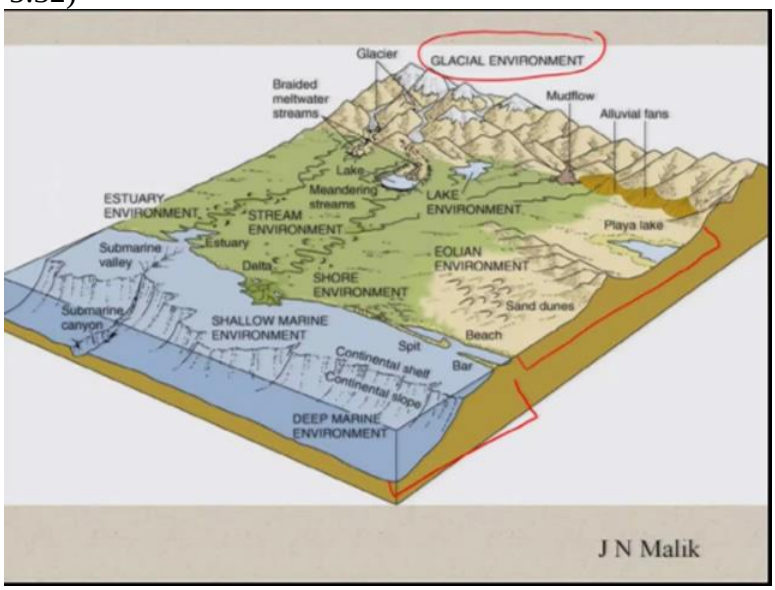

So if you look at different environments where you will find the sedimentary rocks are one is the glacial environment you are having okay. So you are having the glacial environment one. Then here you will have the different type of environments which are on **on** the land here. So we can have either the lake environment we can say the fluvial environment or we can say the Eolian environment.

So we are having different environments which are related to this and then we can see most of the different type of rocks, sedimentary rocks in different environments and finally what we are having here is your marine environment okay. So this figures it explains that the different type of environments which are related to the fluvial system and then you are having different type of environments. Either it is shallow marine or the deeper marine environments.

Or it is an estuary environment that is related to the coastal regions. And then we are having glacial and those are in the higher mountain regions okay. At the foothills zones, you will find their alluvial fans okay. So you are having different environment there. And then of course you see and desert area where we mostly see the Eolian deposits or the Eolian environment okay.

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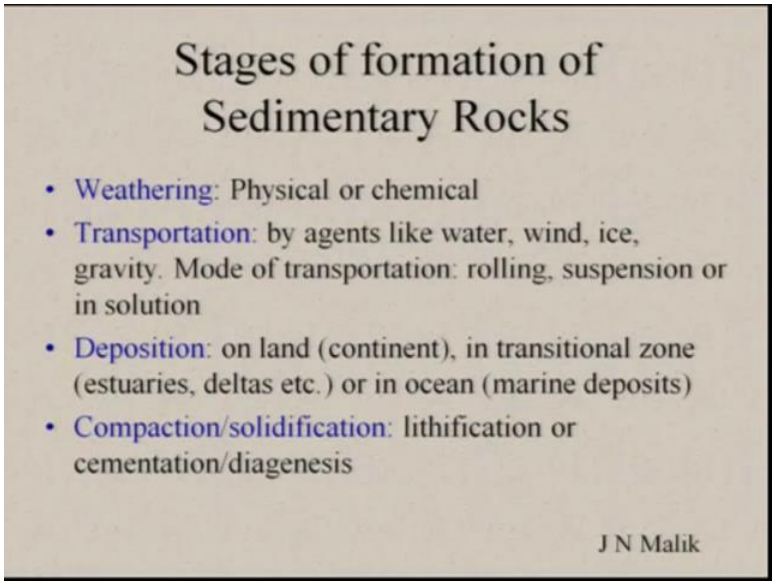

So sedimentary rocks mainly, so stages of the formation of the sedimentary rocks if you look at, then what we see is that there are different stages. The 1st is the weathering. So as we have seen that volcanic rocks come to the surface and of course those rocks will be subjected to weathering either by the rain or the agency either the water or glacier or wind. So they are subjected to weathering.

So physical or chemical weathering will take place. And then we are having transportation by the agents like water, wind, ice or the gravity. Mode of transportation is either rolling or suspension. So either they are being draped out or rolled out on the surface. They are transported in suspension water or in form of solution okay.

Then deposits and, where it will take place? It is on land, that is continent. In transitional zones, estuaries and deltas. Or in ocean, marine deposits mainly.

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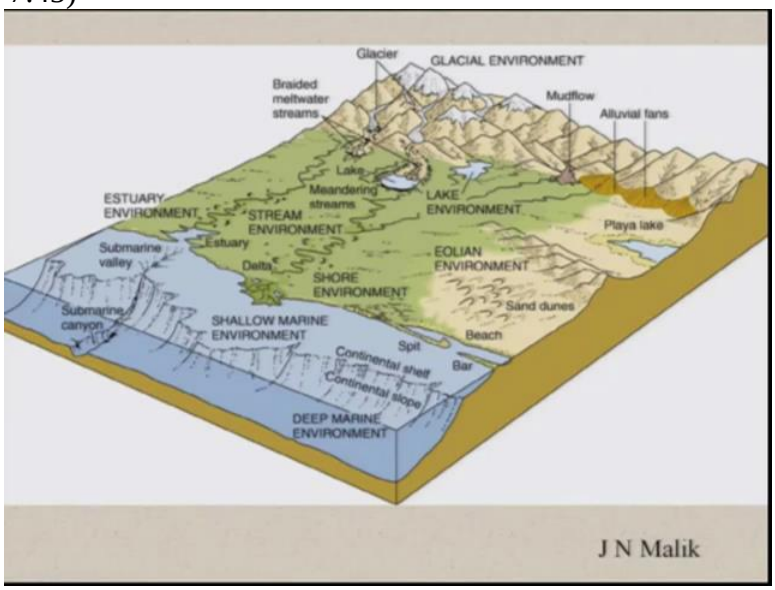

So if you look at this one, what we were looking at okay? So we will be able to, you will be able to understand that what we see okay. So from here, we are having the erosion. And then we are having transportation through this. Of course, deposition will take place and then we are having the deposition over here, that is in the marine environment okay. And then finally, we are having solidification that what we call the lithification, cementation, diagenesis. Diagenesis is alteration of one mineral to another mineral okay.

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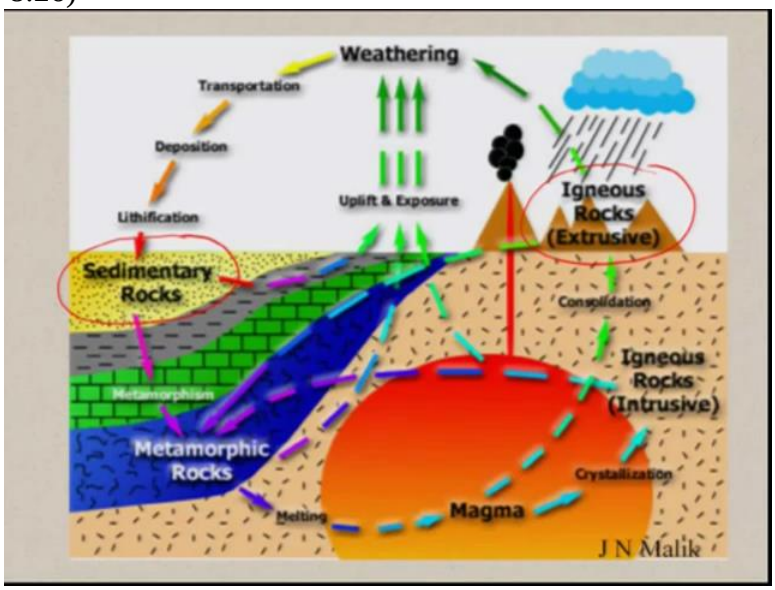

So recalling the rock cycle if you look at, so we talked about the igneous rocks coming right up to the surface through interior of Earth in form of or through volcanic eruptions in form of

magmas and all that. Then there was subjected to those rocks, we have talked about the different types of rocks. Either granite, rhyolite, andesite, diorite, and basalt, gabbro, different type of either they are intrusive rocks or exclusive rocks.

They will be subjected to weathering okay. And weathering will further you will have transportation, you will have deposition and you will have lithification or cementation resulting into the formation of volcanic rocks here okay. So up to this we will talk in this lecture that how different type of sedimentary rocks are formed and what are the different type of sedimentary rocks okay.

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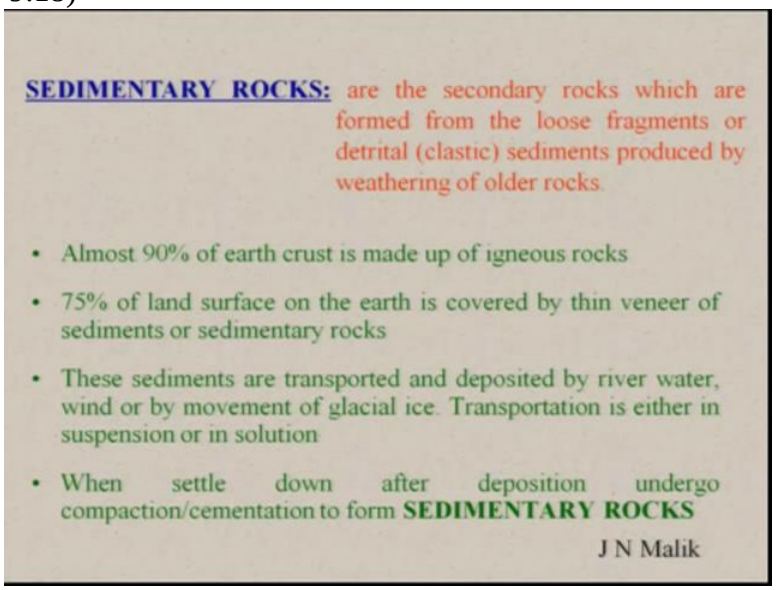

So sedimentary rocks are the secondary rocks because the primary rocks are your volcanic rocks okay. So these are the secondary rocks which are formed from the loose fragments or detrital okay or the class, smaller class okay of sediments produced by weathering of older rocks okay. Almost 90% of Earth's crust is made up of igneous rocks and 75% of land surface okay. So surface on the earth is covered by thin veneer of sediments or sedimentary rocks.

The sediments are transported and deposited by River water or by wind or by the movement of glacial ice okay. So these are the agents which will transfer the deposit. Of course the transportation is due to the wind action okay. So transportation is either in suspension or in form of solution. So when settle downs after the deposition it will undergo cementation or compaction resulting into the formation of different type of sediment we rocks.

Of course, here also the mineral composition is important. And the nature or the process of formation is extremely important for the different type of sedimentary rocks okay.

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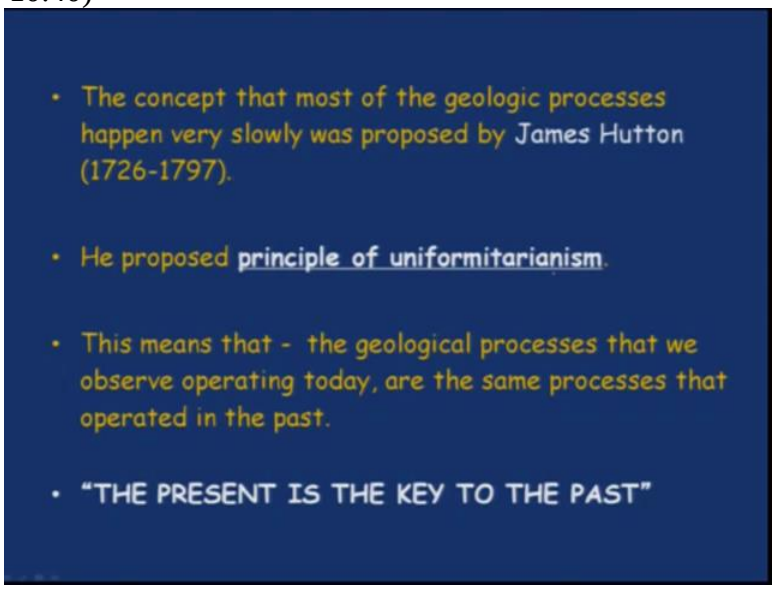

So the concept that was being given by James Hutton long back okay **that the** that most of the geological processes happen very slow in nature okay. So we propose the principle of uniformitarianism. So he suggested that all the processes are very slow in nature okay. And this means that the geological purposes that we observe operating today are the same processes that operated in the past okay.

So he wanted to compare that whatever the purposes we see today happened in the past also okay. So it was the uniformitarianism. So the processes are uniform, it remained uniform in the past also. So that is what he termed as, "THE PRESENT IS THE KEY TO THE PAST" okay.

So if you understand the present process, you will go back into the ancient period or the time or the geological timescale and try to understand that how those rocks were formed, how the landforms were formed and how the erosion resulted into the formation or the erosion resulting into different type of sediments which were being generated or the classic or the detritals okay.

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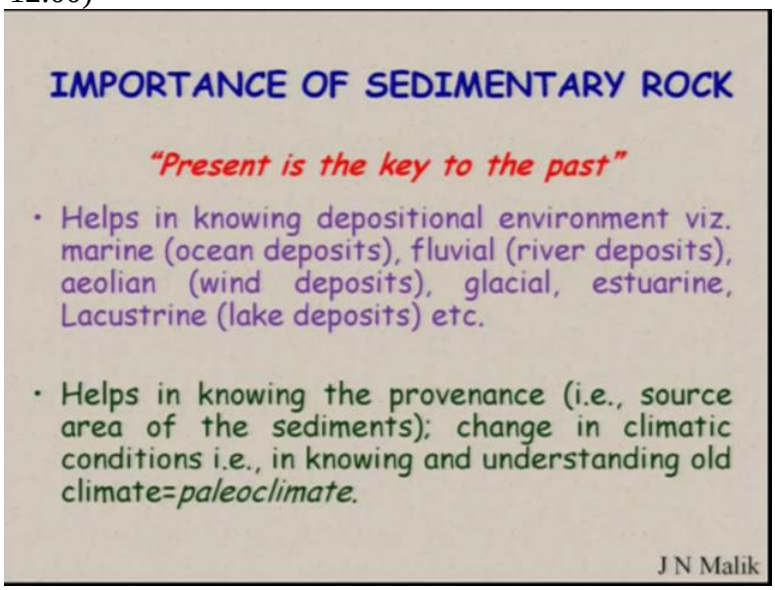

So the importance of the sedimentary rocks, present is the key to the past okay. Helps in knowing the depositional environment okay. This is very important okay. And then either the depositional environment is marine, ocean deposit or it is fluvial deposits or it is the aeolian deposit, glacial, estuarine, locustrine. Now why it is is important?

When you look at some areas like for example, in Himalayas, we see marine deposits okay. From where it came? Because right now we do not have any ocean in that area okay. And based on the fossil contents and all that, geologists and palaeontologists they have identified that the Himalaya rocks, some of the Himalayan rocks are rich in marine deposits okay.

So how those marine deposits came? So they can go back into the is free and try to identify if we understand the present process, we can get back into the history of the formation of different rocks and understand the depositional environment or the formation of those rocks, how they were formed. Either they were in the fluvial that is Riverine environment or they were in the glacial environment or near the estuaries and all that okay.

So it is important to understand the present process to understand the past okay. So it helps in knowing the provenance, from where that is the sediments came, that is the source or the area of the sediments and then change in the climatic conditions that this in knowing the and understanding the old climate okay. That is we call the ancient climate or the paleoclimate okay.

So that helps also in understanding that what was the climate during that period okay. So that is again a very important part.

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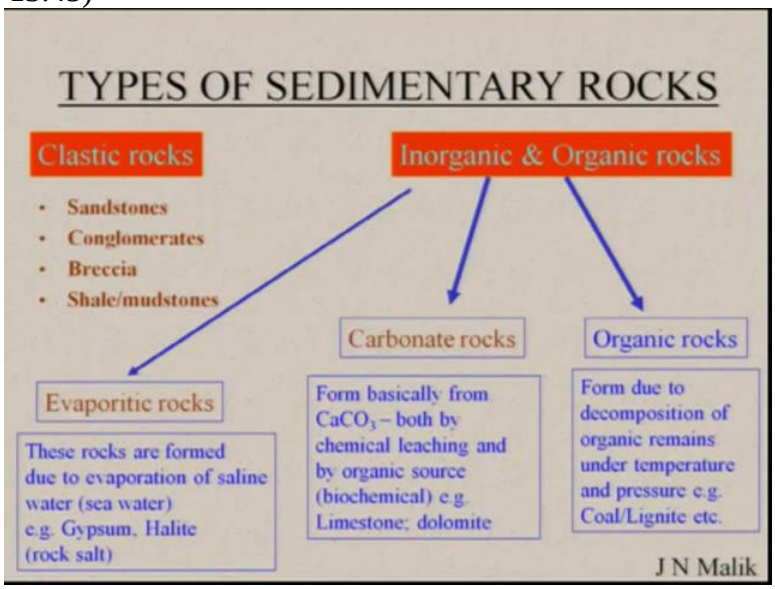

So type of sedimentary rocks if you look at, we are having clastic, we are having in clastic, we are having sandstones, conglomerates, Breccias, shale and mud stones. And then we are having inorganic or organic rocks which are our evaporites or evaporitic rocks. These rocks are formed due to evaporation of saline water mainly the seawater and the examples are gypsum and highlight which is also termed as rock salt.

And then we are having the carbonate rocks. Mostly comprised of calcium carbonate, both are formed chemically by chemical leaching and by organic sources okay. So we are having biochemical rocks also. The example is limestone and dolomites okay. So you can say that this is the process where mostly you will be able to see in the marine environment okay.

And then we are having organic rocks. Of course formed due to decomposition of organic remains under high temperature and pressure. Example is cool and lignite okay. So we has clastic rocks and inorganic and organic rocks if you like to see the different type of sedimentary rocks okay.

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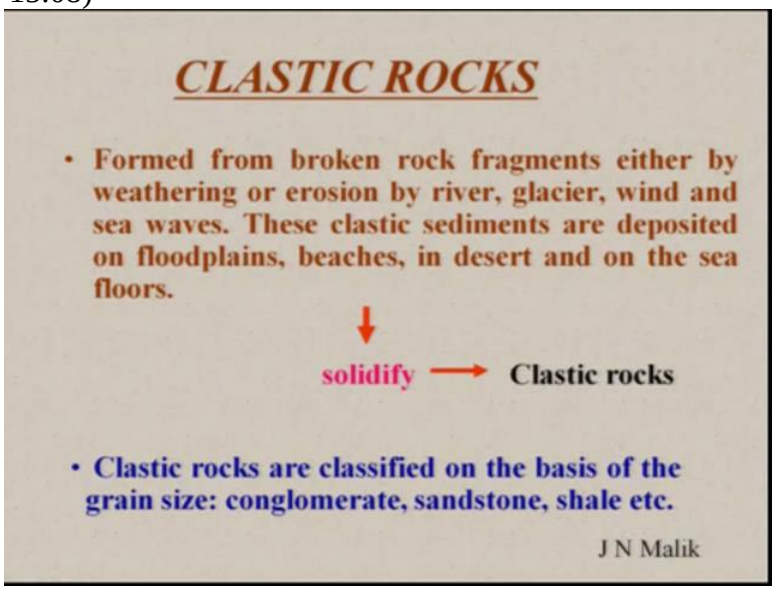

So these are the examples of the inorganic rocks which are comprised mostly of the minerals which are formed due to precipitation, your gypsum, halite, haematite, limonite, calcite crystals, dolomites and then we are having microcrystalline quartz which are also termed as Chert. So this is because of the formation of the or we can classify this as an inorganic chemically rocks formed due to chemical processes okay.

Then we are having clastic rocks mainly will have the grains or the fragments okay. So they are formed by the broken rock fragments either by weathering, erosion, this we have talked about. These are the different agents by which you will have the formation of the clastic material okay. And then solidifies, cementation and then we would say it is in clastic rocks.

Clastic rocks are classified on the basis of grain size okay. So, conglomerates, sandstone, shale, so we are having larger grain size yes and then it reduces and becomes finer up to the clay size okay. We will see the grain size, that based on the grain size how they are being classified okay.

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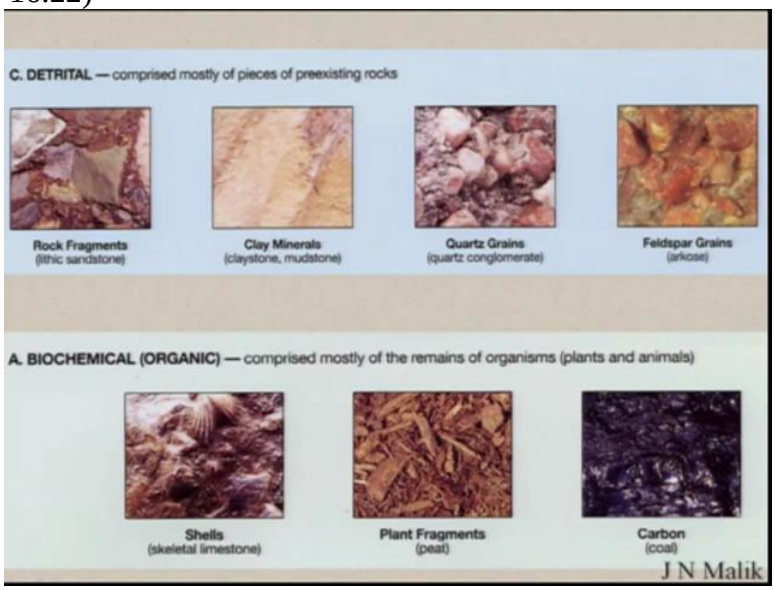

So if you look, then we are having the detrital rocks. So one we are having the chemical, plastic and then we are having detrital rocks. So these were the this we are talking about the chemical rocks and then we are having the clastic rocks mainly okay. So detrital comprises mostly of the pieces of pre-existing rocks okay.

So you will find, within those rocks you will find some fragments of the old rocks. You may have some igneous rock fragments or maybe you will have metamorphic rocks fragments and all that. So we are having what we call lithic sandstones were then we are having clay minerals, clay sandstone, then we are having quartz and all that. So we have quartz conglomerates mostly.

And then we are having some of the feldspars here. We can say arkosic rocks. And then we are having another one is organic or biochemical rocks okay. And these are mostly you will find the marine organisms here for the fossils okay which are comprised like skeletal limestones, we can term shales. Then we are having plant fragments which are rich in that.

We also term that as peat and then we are having carbon rich is whole actually. So these are again, another set of rocks, sedimentary rocks which are organic in nature okay.

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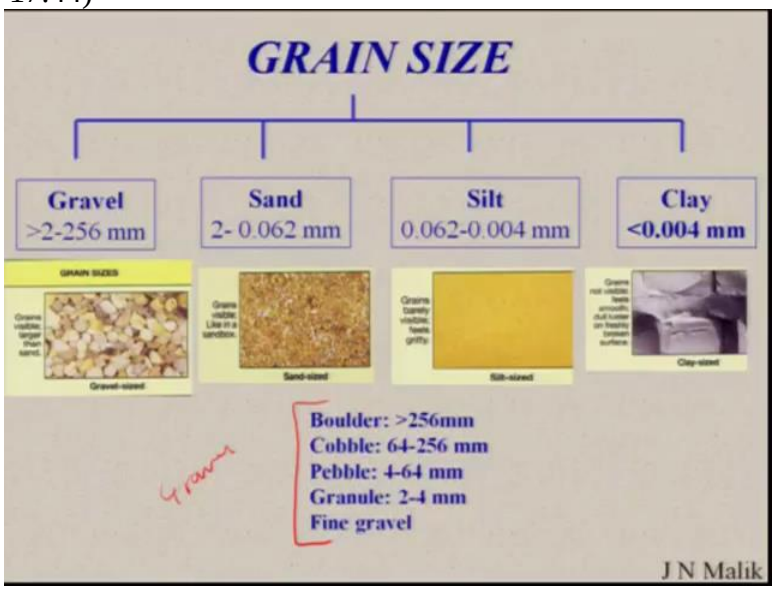

Now based on the grain size if we look at, then we see the grain size which is having the in mm if you look at greater than 2 to 2566 mm, we term that as a gravel okay. And then we are having sand which is ranging in size from 2 to 0.062 mm. and then we are having silt which is which ranges in size between 0.062 to 0.004 mm. and then we are having clay which is less than 0.004 mm okay. So most fine one.

So grain size, based on this if you are having like boulders, then we can say that it is greater than 256 mm, cubble is 64 to 256 mm, then pebble from 64 to 4 mm and granule from 4 to 2 mm and fine gravels okay. So these are all been categorised in gravel okay. So we have gravel here. It is different. Even if you can have the boulders, you can say the because the size is ranging here for the gravel.

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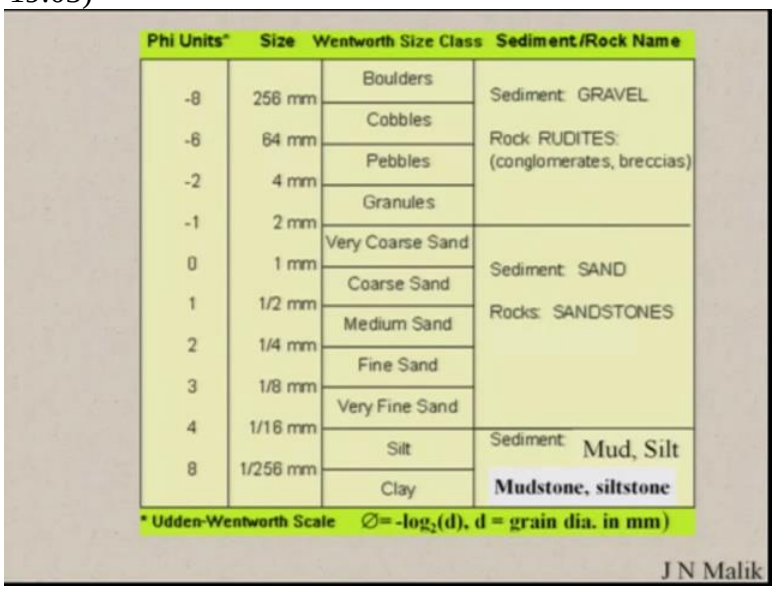

This is another scale which has been given in phi and this is a logarithmic scale which has been used to compare the grain size from the finer to coarser, ranging from clay right up to the boulder okay. And these are the different type of rocks, sedimentary rocks which are being termed or categorised based on the grain size we are having okay. So we are having coarser ones, then we are having the gravels, then we are having the comparatively finer.

Then we are having sand for sandstone here. Whereas we are having quartzite sorry conglomerate and Breccias and then we are having finer ones which are made up of silt or play. We have much stone, siltstone,etc.

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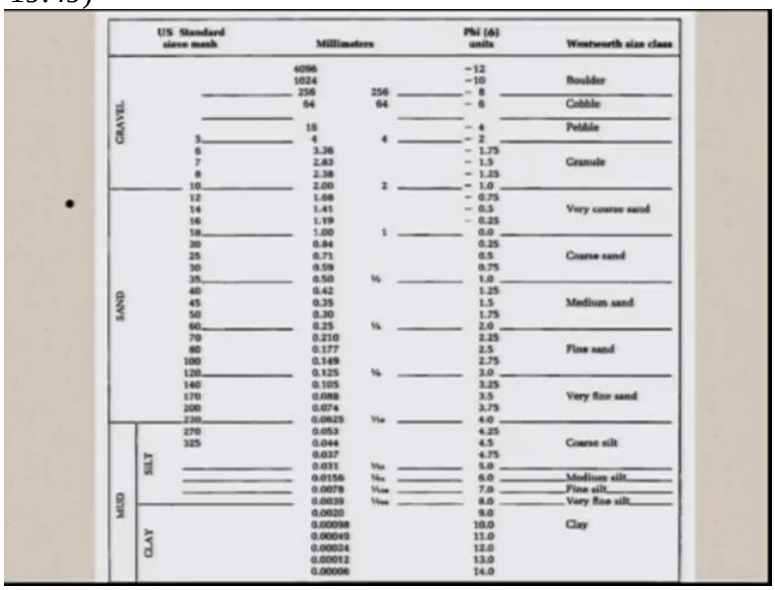

This is again the similar one which you can refer which talks about the different phi scale and the grain size here in mm we are having and the different type of rocks we are having here okay. Or this is the grain size basically okay. Based on this we can say, either this is a coarse grain sandstone or a medium grain sandstone or a fine-grain sandstone and all that okay.

So this is the grain size which has been given which is important for classifying the rocks and saying that whether it is gravel ridges rocks or it is a sandwich rock or it is the finer which is a smart stone or siltstone.

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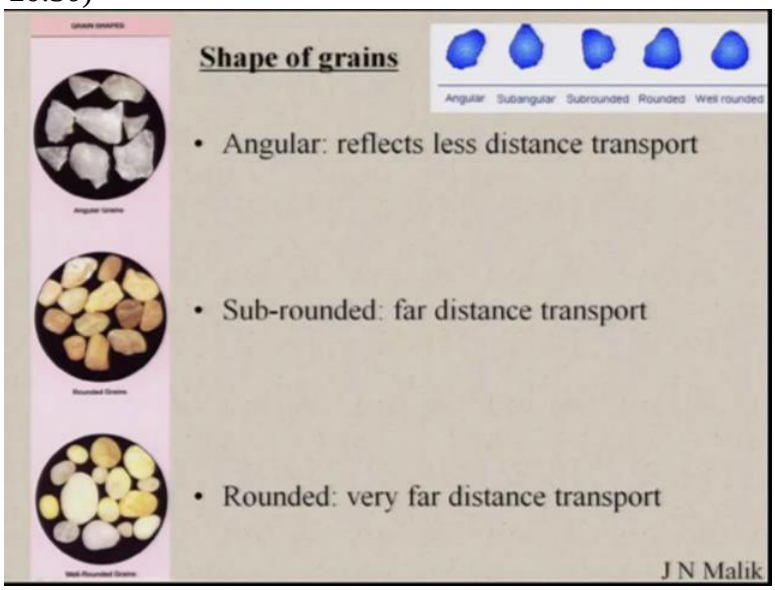

So then another one is, 1st is the you can use the that what is the it comprises the chemical composition also can be used. Then we are talking about the size. Then we are talking about the shape of the grain. So based on the shape of the grains also, you can classify the rocks and you can understand that how far they were been deposited okay from the source okay. That the sediments were carried far away from the source or they were been having the shorter distance transport okay.

So based on the shape, you can talk about that whether it is angular, sub angular, sub rounded, rounded or well rounded okay. So this is again the classification which has been given in terms of the grain shape we are having. We are having angular grain shape. We are having rounded and we are having well rounded okay. So we can also say this as a sub rounded okay.

But this is well rounded one okay. So angular reflects less distance transport. So this you can easily make out looking to the hand specimen. And the hand specimen, different types of sedimentary rocks you can if you are having angular fragments within it, then you can say that these are the deposits which reflects less distance transport. Then sub rounded, far distance transport and rounded, very far distance transports okay. Again, this will show the abrasions when the grains are travelled are transported, they are transported in bulk okay.

And rubbing to each other, there will be breaking and shaping up of the different rocks which we call during the time of, so abrasion will take place during the transportation which will also, so longer time if you put to the different grains then it will have the more rounded shape okay. Hence rounded will indicate long-distance transport okay.

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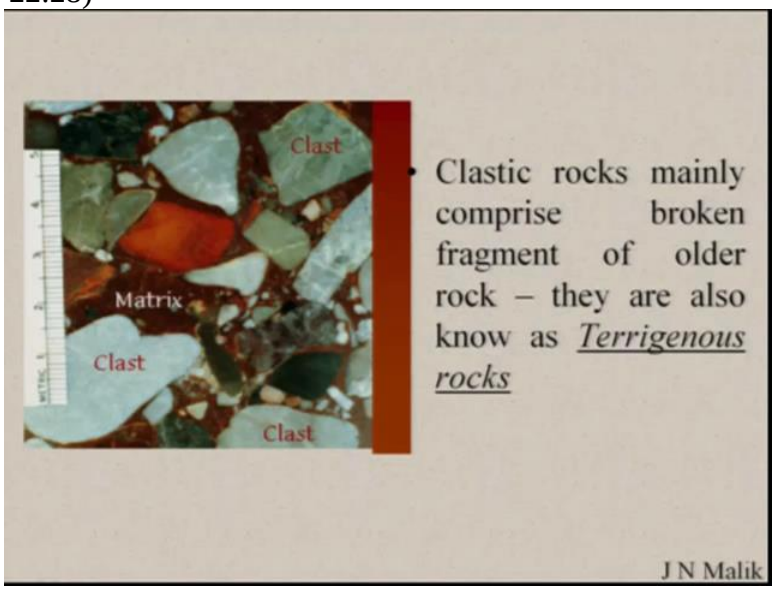

Then we are having for like for example this is what we call the terrigneous rocks. Clastic rocks mainly comprise of broken fragments of older rocks. They are termed as terrigneous rocks. So we are having different clast here and then we are having matrix and all that okay. But we have the clast of different type of rocks here.

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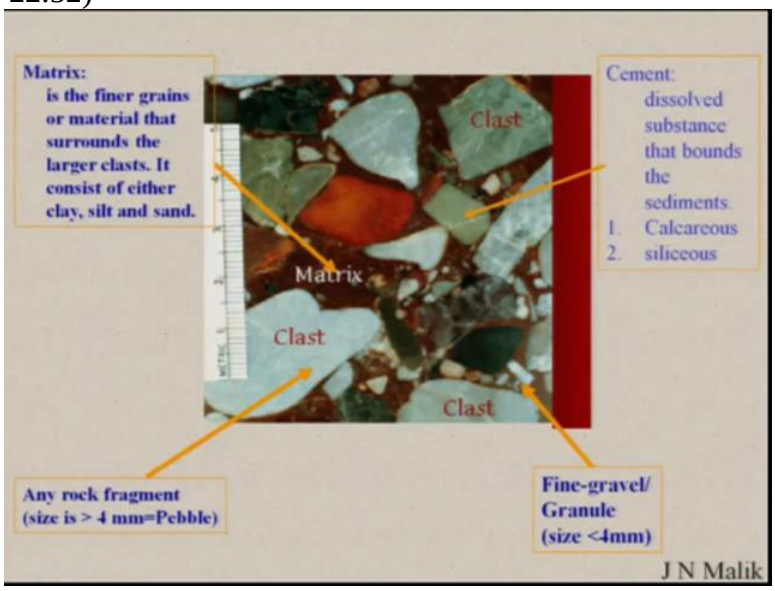

So mainly the any rock fragment having the size which is greater than those which are termed as pebbles, greater than 4 mm and then we are having the finer granules which are less than 4 mm and we are having matrix which are the fine-grain material which surrounds the larger clast okay.

And then we are having the cements okay which is dissolved substance which bounds the. So this is what we will have within one terrigneous rocks okay.

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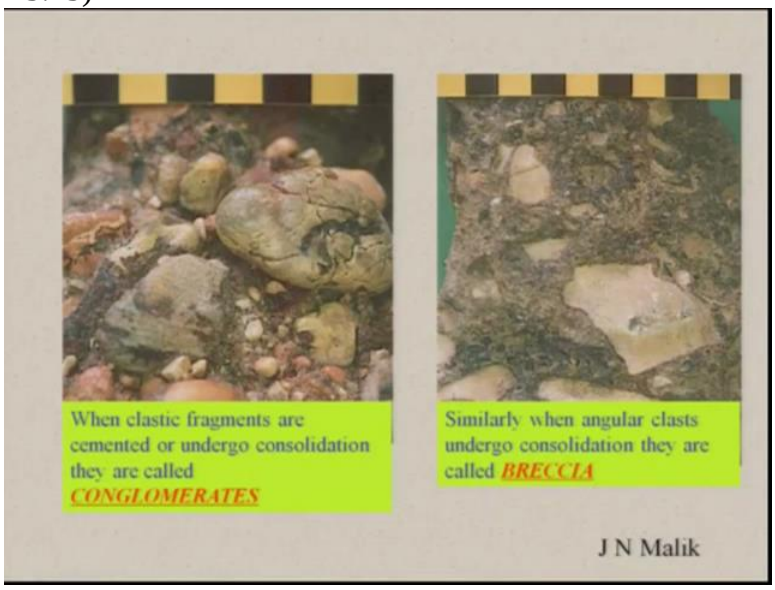

Then we are having conglomerates which is comprised of clastic fragments cemented within the ground mass okay. So we will have all the pebbles and cobbles within that., You can term that as a conglomerate and mostly the grain size or the grain shape will be rounded to sub rounded. If you are having angular clast and which are constituted in the ground mass, they are termed as Breccia okay.

So they are very much similar but the only the shape is different okay. So these are breccias are having angular fragments of different rocks whereas these are having the rounded clast okay. That is conglomerate.

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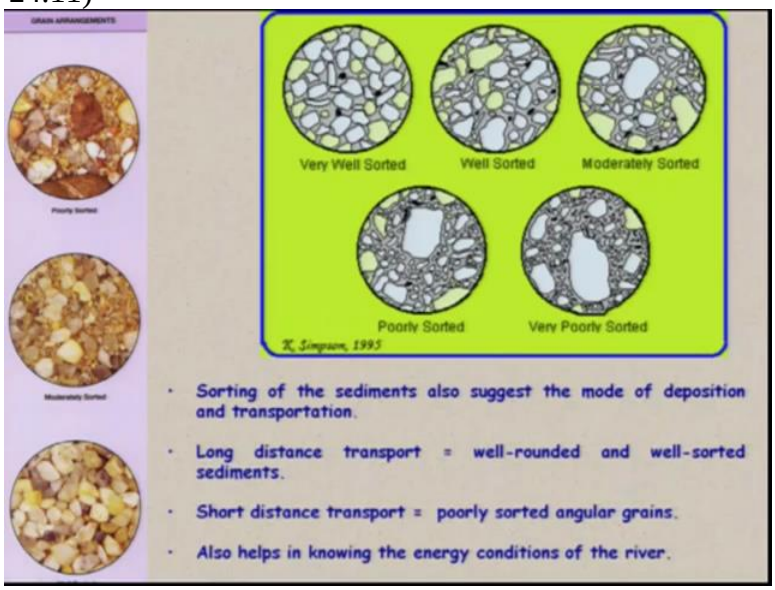

So based on the rounding also again, we can sort we can say that we can sort out the different type of rocks and we say the sorting of the different type of rocks, either they are very well sorted, well sorted, moderately sorted. Again they will talk about the transportation okay. Sorting of the sediments also suggests the mode of deportation and transportation.

So long-distance transport will have well rounded and well sorted material okay or the clast. Whereas the short distance transport will be poorly sorted and angular in shape okay. So this also, sorting of the material also helps us in identifying the deposition and the transportation mode. So this is again important, another criteria which has been used which helps in knowing the also the energy condition.

Far distance transport will have well rounded and sorted material. Short distance transport so the river is incapable of transporting the material or any other agency which we were talking, not capable in transporting the material. So we will see the poorly sorted and angular deposits okay.

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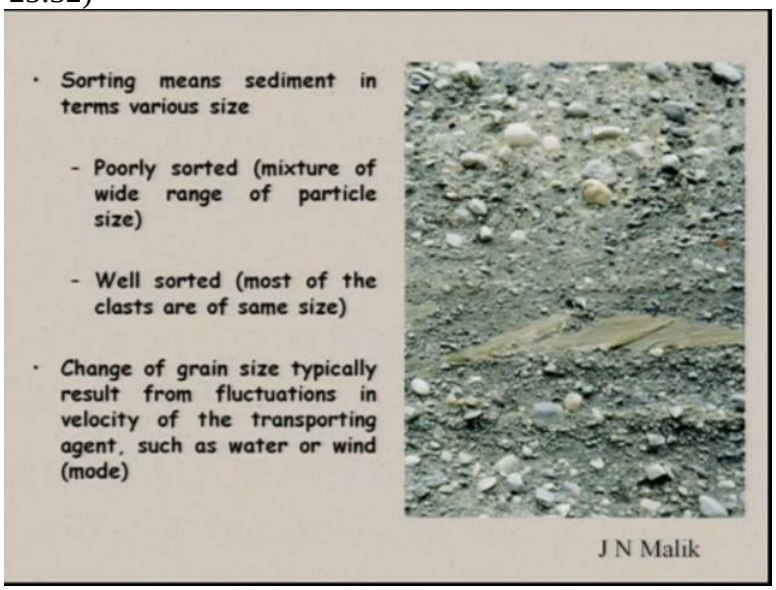

So this is one of the examples which talks about the section if you look at from the bottom to top okay, it has different grain size if you look at here, you have different grain size which comprises of subrounded clast okay and then we are having the finer ones and then we are having again this is what we call moderately sorted, poorly sorted here. Again they are poorly sorted. Then we are getting in finer deposits here.

Then started getting coarser one and then again you are having the coarser deposits here along with the matrix okay. So sorting means sediments in terms of various size. So poorly sorted mixture of wide range of the particle size okay. So in terms of we can take the well sorted, most of the clasts are of the same size. Whereas here you will have wide range of particle size in terms of the poorly sorted material.

And then we are having the deposits, the change in the grain size. Typically it results from the fluctuation in the velocity of transporting agent okay. Either it is wind or water. So if you are having fluctuation of the energy conditions orr the velocity, you will have that will affect the sorting of different deposits. So either the deposits are termed as poorly sorted or well sorted okay.

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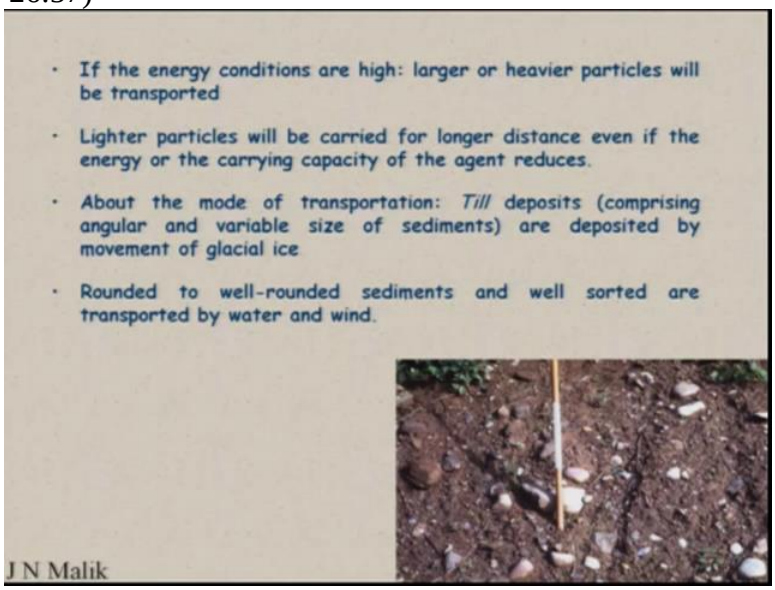

Then if the energy conditions are high, larger or heavier particles will be transported okay. Then lighter particles will be carried for longer distance even if the energy or the carrying capacity of the agent reduces. So you will find that most of the time that we have finer deposits which are seen in the plain areas, the alluvial plain areas where the rivers are incapable of carrying the coarser bed loads okay.

But the finer ones were been will be transported right up to the mouth of the river and that goes up to the in the ocean also okay. So about the mode of transportation till deposition. Till deposition is a term which has been given which is comprised of angular and variable size of sediments okay and are deposited by movement of glacial ice okay. So the glacial deposits mostly which is comprising the angular and variable size of sediments are termed as till deposits okay.

Then rounded and well rounded sediments, and well sorteds are transported water and wind okay. So one can easily differentiate if you are having more variable size sediments and they are angular in shape. So you can say that probably it represents the glacial environment. Of course it is again a short distance transport okay. It is not a very long distance transport.

So mostly the wind and water will have the capability of transporting the sediments for longer distance okay. Hence we see, in fluvial and Aeolian deposits we see well rounded and well sorted deposits at many places okay.

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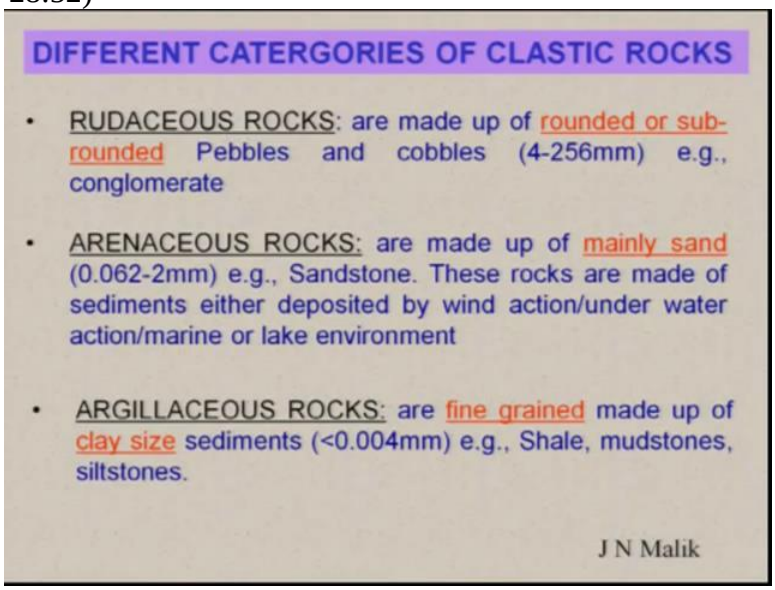

The different type of categories of clastic rocks mainly if you take, we termed those as rudaceous rocks which are made up of rounded to subrounded doubles and cobbles. So size range is from 4 to 256 mm. example is conglomerate. And then coming to the next page that is finer one little bit which ranges in size of 0.062 to 2 mm. Examples are sandstone and they are mainly comprised of sand which are termed as arenaceous rocks okay.

And then finer ones which are comprised of play, less than 0.004 mm are termed as argillaceous rocks and these type of rocks are mostly the shale or mudstones or siltstones. They are fine-grain rocks. So we are having rudaceous are the coarse grain, rounded to subrounded material. Arenaceous rocks, mainly sand and then argillaceous which are fine grain sedimentary rocks mostly comprised of clay size sediments okay.

So these are based on the different category of clastic rocks. We are having rudaceous, arenaceous and argillaceous.

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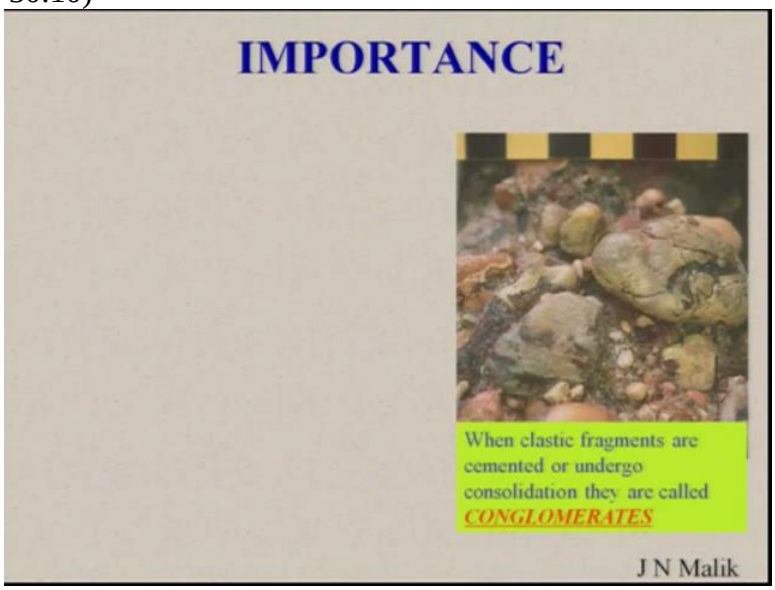

So these are termed, these are the rudaceous rocks which we are having the conglomerate. And now importance of this if you take okay, what we are having the mixture here is we are having the rounded to sub rounded fragments within the conglomerate and surrounded by matrix here okay. So we can continue this in the next lecture okay and then we will talk more about the different type of rocks. Thank you so much.