Earth Sciences for Civil Engineering
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Module 2
Lecture No 9
Rock types and their Properties (Part-3)

So after the laccolith, one of the major form of igneous rocks is batholith okay.

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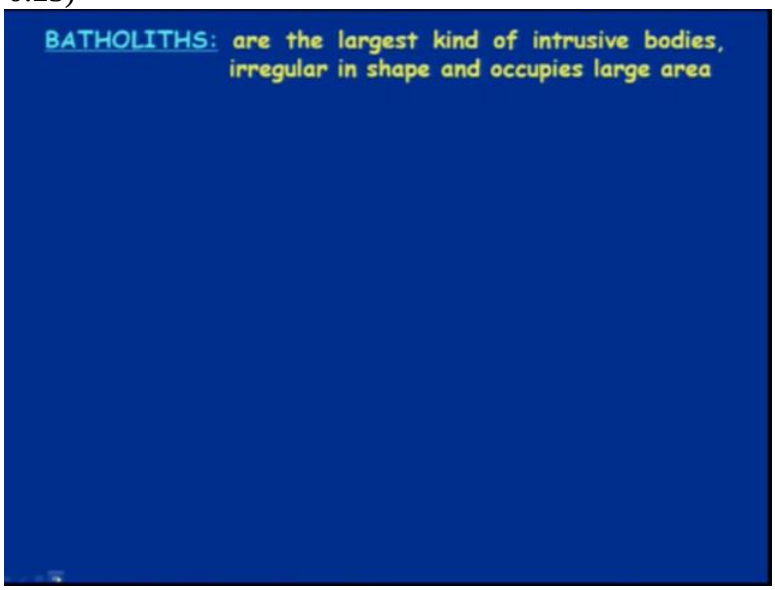

And batholith again are the largest kind of intrusive bodies. Irregular in shape and occupies very large area. As compared to dykes and all that we were talking about that they were vary from 10 to 100 m and all that but this will occupy (())(0:41).

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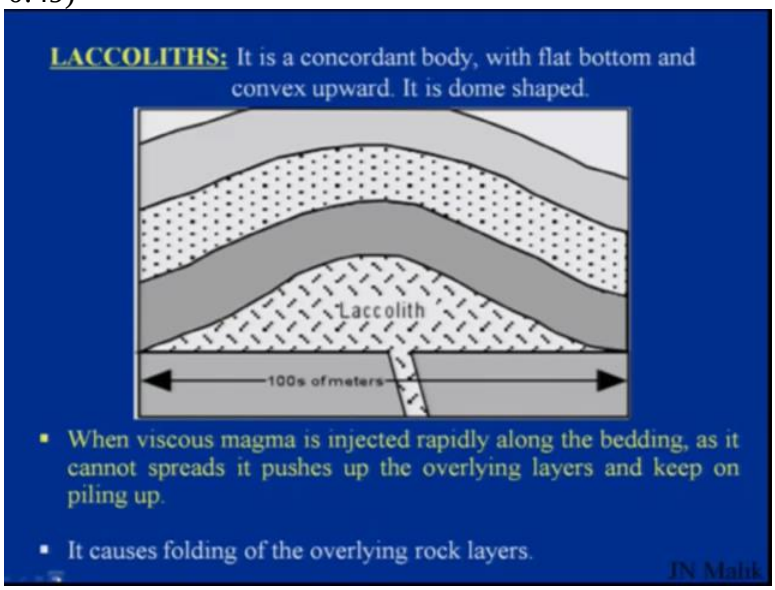

So like other igneous forms or the structures, batholith is another structure which is one of the largest kind of intrusive body which is irregular in shape and occupies very large area as compared to the other forms which we have discussed like dykes, sills and all that okay.

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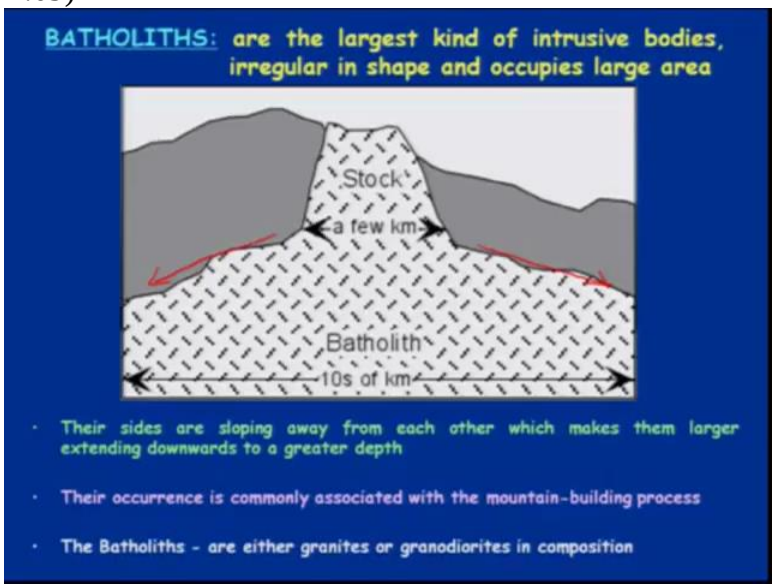

Now if you look at the batholith, it will have almost like tens of kilometres it will cover at the basal part. And on the top area the this the which is going towards the surface is termed as stock okay. And that will be having again it covers an area of about few hundred few kilometres okay.

But batholiths are mostly the areas which are which covers larger region okay in terms if you take the compare with other igneous structures or the other igneous intrusive bodies.

So these are having the slopes if you take, it is dipping away from one another. Hence we see at the greater depth you will find that they are covering very large areas okay. So their occurrence is commonly associated with mountain building activity. So were we are having subduction zones and all that, we will find this type of intrusion intrusive bodies okay. And batholiths are either comprised of granite for granite iodide in composition.

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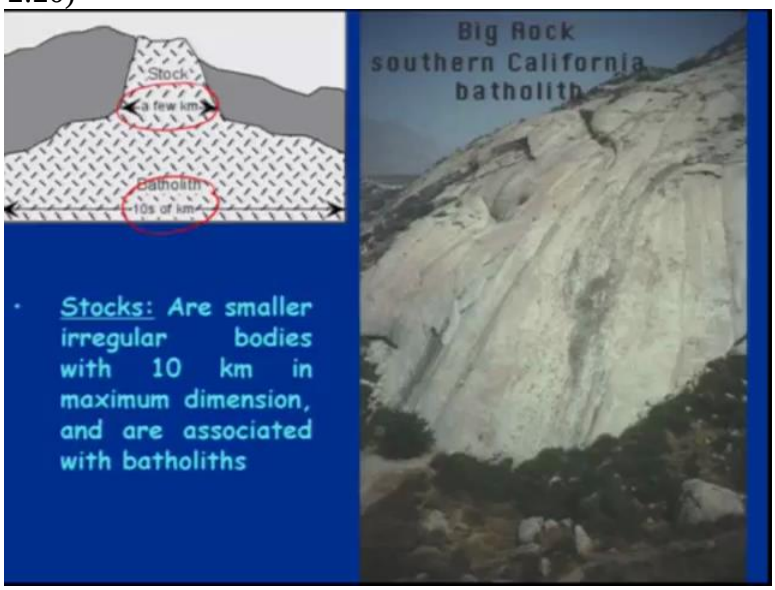

And the another associated intrusive body is the stock okay. So stock as we have we are talking about that will be of a few kilometres okay. And it may be around 10 km in maximum dimension. And they are always associated with the batholiths. So batholiths will cover larger area at the bottom and on the upper part we will see the stocks okay. And this is one of the best example of stock or the batholith in US, California.

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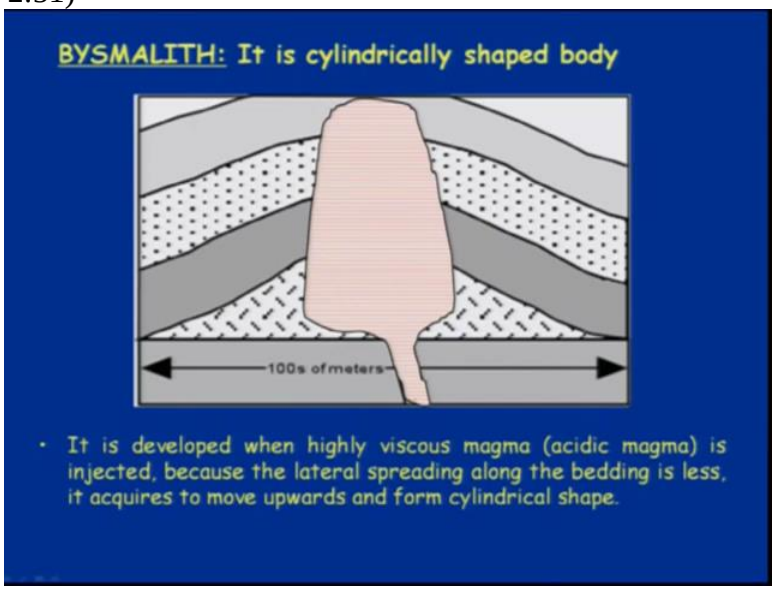

Now this is another one which is termed as bysmalith. It is cylindrical shaped body again and what we see is that that this is very much similar to the laccoliths what we find this as an as an intrusive body within dyke at the in the at the depth. And the top, we have some intrusion like what has been shown in the figure okay. So mostly it is developed when highly viscous magma which is acidic in nature is injected because of the lateral spreading along the bedding and it acquires to move upward and form a cylindrical shape okay. So this is the body which is termed as bysmalith okay.

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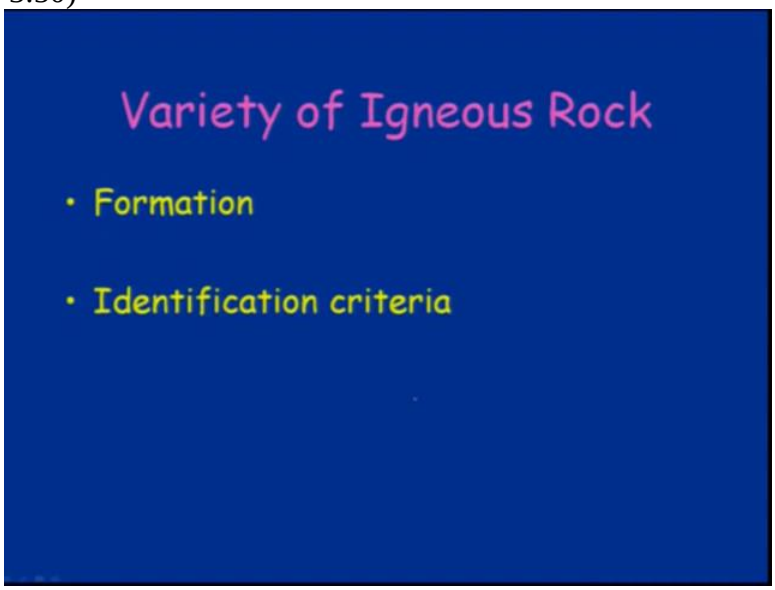

So we move further and look at the variety of igneous rocks. So formation of igneous rocks and identification criteria we will see how we can differentiate one rock from another. And how we can differentiate whether it is an intrusive rock or it is an extrusive rock okay.

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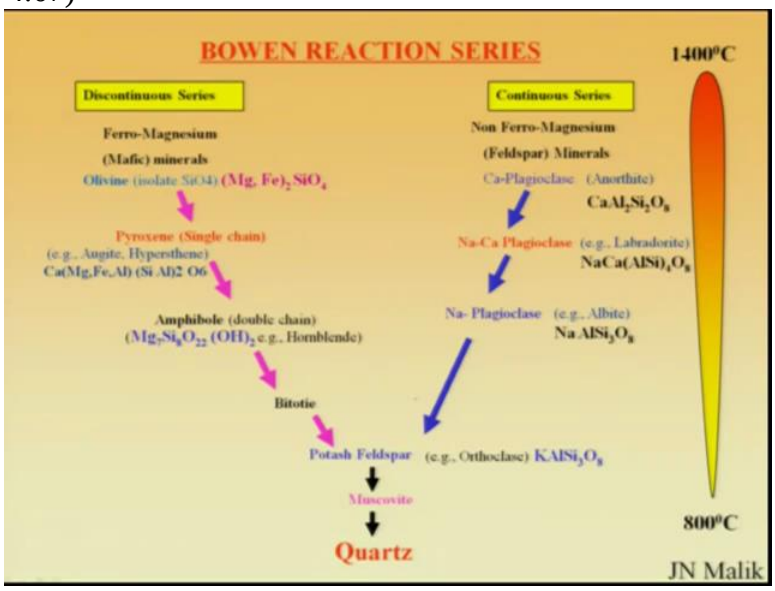

So as we discussed in the lecture of mineral different types of minerals, we looked at the continuous and discontinuous series and we discussed about that how the minerals are formed at different stages. And as we have discussed in the beginning that cooling of magma will affect the formation of different crystals and formation of different minerals okay.

So please recall these 2 series that is discontinuous ferro-magnesium series and the continuous ferro-magnesium mineral series okay. So combination of these minerals we will usually we will be able to see that the different type of rocks in different type of rocks okay of igneous rocks mainly.

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So as for example, if you take granite, so granite is comprised of orthoclase feldspar. Then you are having Quartz, then you having biotite and plagioclase feldspar okay. So so it is mostly the aggregate of different minerals okay. And that is what we have we are talking about that what is rock if we take, rock is an aggregate of different minerals okay. So here we are having number of minerals. Plagioclase, orthoclase, biotite and Quartz okay. So we have that that that is the composition of the minerals.

So different rocks will have different composition and we will learn as we move ahead in this course while talking about its different type of rocks that these minerals will also provide strength to different rocks okay. So hardness of the rocks, the durability of the rocks in terms of the weathering will depend on the Constitution or the composition of different minerals okay. And you have to remember the hardness scale which will also help you in understanding that which mineral is harder and which mineral is softer okay.

So harder and softer will also have will have the effect of weathering okay. So the harder minerals like for example we are having Quartz is 7, hardness. It is much comparatively harder and most of the rocks will have this one okay. Rest of the minerals will get eroded or weathered but this will be will remain in the in the deposits okay or in the rocks.

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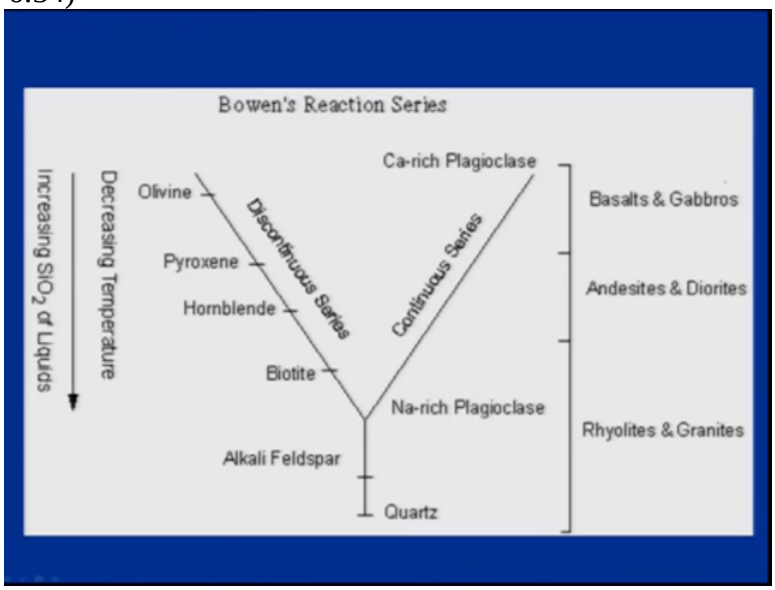

So let us move ahead and see. So this is again comparison of the Bowen reaction series. Different type of minerals which are informed with the continuous series and the discontinuous series here. And with the with the different composition different rocks are been named here. So we will talk in detail about what is basalt, what is gabbro, andesite, and diorite, rhyolite and granite okay.

Now these are the different rocks which are which we will see that how they are classified as an extrusive rock or intrusive rocks okay. So as the temperature decreases and increase in silicon percentage and the liquids, different type of rocks are formed and different type of rocks are comprised of or they comprise different minerals here okay.

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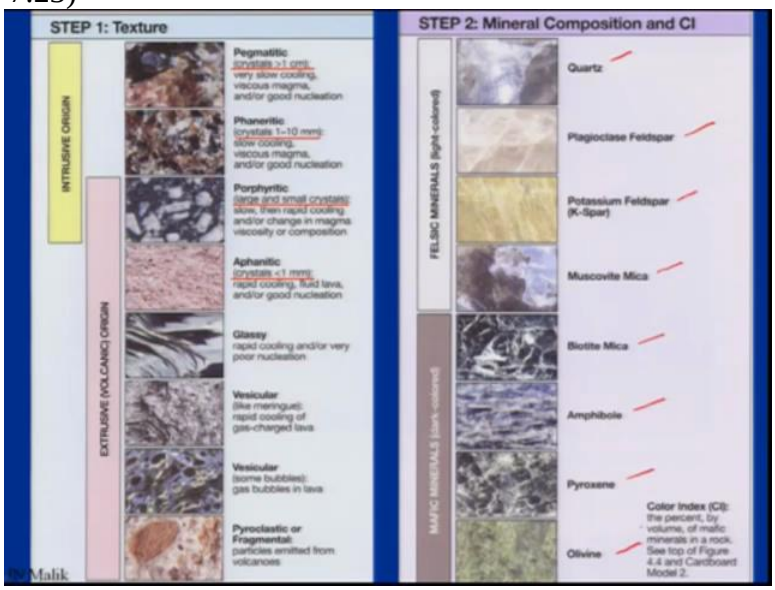

So the another most important other than the composition is this is the criteria which we follow to identify the rocks is the texture. And we have different type of texture and textures are again which are being classified based on the grain size mainly. So we have like the textures which are associated with the intrusive origin and textures which are associated with the extrusive origin.

So as we have discussed in the in the previous lectures that fast cooling okay will result into the fine-grain crystals or the fine crystals formation or and the slow cooling will result into the coarser is crystal. So based on the size of the of the Crystal, they have termed as like the crystals having the size greater than 1 cm, very slow cooling. Hence the we talked about they are not coming right up to the surface.

So they are intrusive in nature. So they remain below surface and cooling is very slow. So they are termed as magmatites and then crystals which are having size around 1 to 10 mm are termed as Phaneretic texture. And then we are having larger and smaller crystals that is a mixture of larger crystals larger than 10 mm or larger than 1 cm or so. And then we are having a ground mass what we say this is the ground mass here and then we are having the larger crystals here which are surrounded by the ground mass.

So this type of texture is termed as porphyritic texture. And then we are having the if you move into extrusive rocks further down, then we are having finer ones, that is aphanetic texture, glassy texture, vesicular and all that. So aphanetic is having like less than 1 mm rapid cooling of

magma. Whereas here is to look at what we see in porphyritic , it is this slow and then so initially there will be in slow cooling which will result into the formation of larger crystals.

Then there is rapid cooling which is probably because of the change in the magma viscosity or the composition okay. So they will have different composition here and that is why it results into the formation of larger and smaller crystals. Whereas if you look at the aphanetic texture which is having the crystal size less than 1 mm will be rapid cooling or very fast cooling will be seen in in terms of the glassy nature of the rocks okay.

Then we are having vesicular, then we are having pyroclastic and all that. This we will talk as we move further while talking about the eruption of magmas and all that okay. So mineral composition is again an important criteria as we have discussed right from the beginning when we were talking about the mineral formation and all that. So mineral composition is one of the major criteria to identify the rocks okay.

So we are having feldspar and silica rich rocks and we are having mafic magnesium iron rich rocks we are having mafic rocks. Now mafic's rocks are basically mostly darker in colour. And the felsic rocks are mostly or the felsic minerals are are lighter in colour okay. So the rocks which are comprised or are having the composition more of a mafic minerals will have, will give you the darker colour okay.

Whereas the rocks which are comprised of felsic minerals will give you the lighter colour. So looking to the rocks in directly, one can identify and one can say that okay fine, this is felsic rich rock and this is mafic which rocks okay. So felsic mostly what we see is Quartz, then we are having plagioclase, pota plagioclase or potash plagioclase, Muscovite, mica and all that.

Whereas if you move to another variety of mica is biotite which is mafic rich and then we are having amphibole, pyroxene and allwyn. So these are very important colour index which you can use to identify the rocks along with the texture part okay. So texture is a crystal size and how the appearance we see of the of the rock surface. And then the mineral composition. So based on the colour index, you can identify the felsic and mafic one okay.

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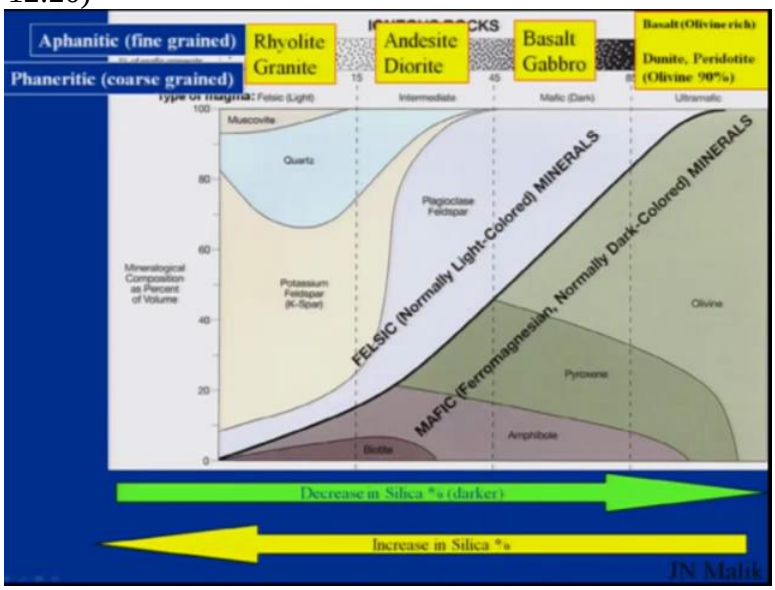

Then coming to the other part which is again is the type of magmas if you look at, so if you look at the type of magma, we are having felsic which is light. And then we are having intermediate mafic which are darker and ultra mafic okay. So it shows that in the felsic are normally lighter colour minerals and mafic ferro-magnesium normally darker colour minerals we are having.

So these are been group in the darker colour minerals, Allwyn, pyroxene, amphibole and biotite whereas lighters are potash feldspar, plagioclase, Quartz and Muscovite okay. So this is based on the colour index. So if you move towards this side and you are having more of the mafic minerals then you will see the darker colours. Whereas you are having lesser mafic minerals, you will have lighter colours having felsic minerals.

So this also indicates that if you move from the lighter minerals to darker ones, you will have decreased in silicon percentage. Whereas if you move towards the other side, you will have increase in silicon percentage. So this is one thing. And different type of rock as I was talking about, then we can have the lighter ones, we are having rhyolite, granite, we are having andesite, and diorite, we are having basalt, gabbro and then we are having basalt and dunite or peridotite okay.

So these are the rocks like dunite and peridotite which will comprise almost 90% of Allwyn okay ferro-magnesium mineral we are having. So let us see one by one how these different types of

rocks look like in nature okay. So we are having, aphanetic rocks which are fine grain. Those are the rhyolite, andesite, basalt and then basalt Allwyn rich basalt and all that.

And when we are having phaneretic coarse grain okay which are grim night, diorite, gabbro. So now if we just recall and compare this with the cooling process okay, then we can also justify that which one is the intrusive and which one is the extrusive okay. So intrusive are the coarse grain because the cooling of magma is slow here.

Whereas the cooling of magma is faster here. So we are having aphanetic. So these all rocks which are been listed here, are the extrusive rocks where as the granite diorite and gabbros and etc are phaneretic coarse grain, are the intrusive rocks we are having okay.

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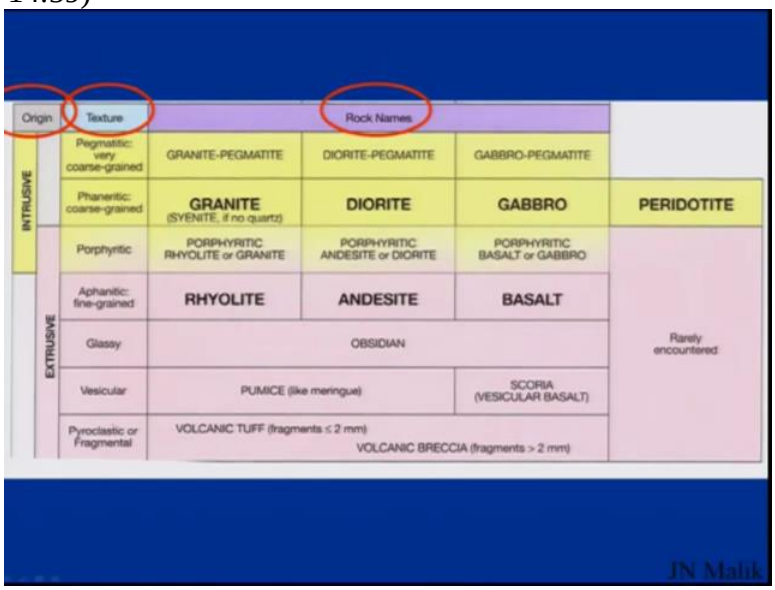

So this is the table which talks about one is the origin, whether it is an intrusive or extrusive rock, intrusive or extrusive rock. Then we are having texture where we classify based on the crystal size or the grain size we are having. So we say pegmtite, phaneretic, porphyritic , etc okay. And then we are having rock names okay. And that is based on the chemical composition.

So these all combinations if you take, you can easily identify the rock and you can you can say whether it is an extrusive rock or an intrusive rock okay.

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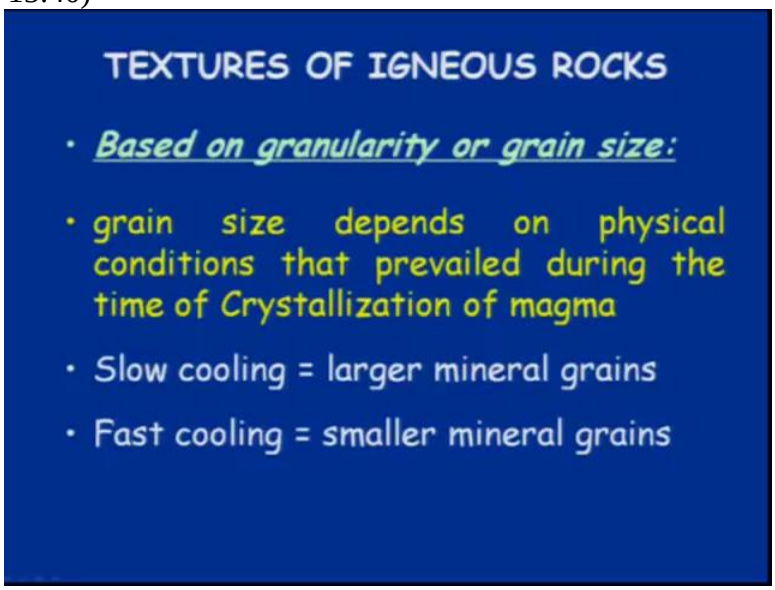

So texture of igneous rocks if you look at based on the granularity of the grain or the grain size we are looking at okay. So grain size depends again on the physical conditions that prevailed during the time of crystallisation of magma. So slow cooling will give rise to larger mineral grains. And fast cooling will result into the smaller mineral grains okay. Hence we see that these are finer grains and these are coarser grains okay. And these are related to the extrusion and this is intrusive rocks okay.

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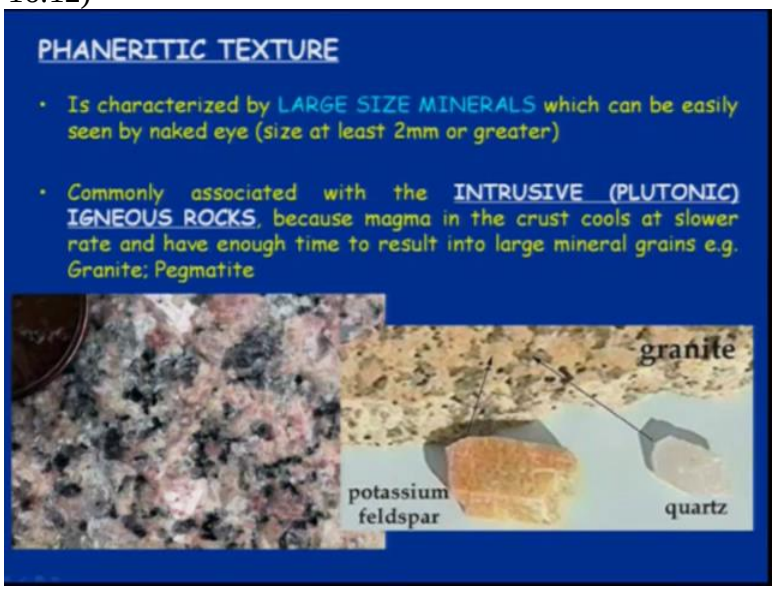

So phaneretic texture if you look at, so we what we see is the coarser minerals okay or the crystals okay. So is it is characterised by the larger size minerals which can be easily seen by naked eye okay. So size is at least 2 mm or greater. And commonly associated intrusive which are also termed as plutonic igneous rocks. Because the magma in the crust cools at slower rate and have enough time to result into the formation of large size of crystals okay.

So example of such type of rocks are granite and magmatite. There are more also but these are these are few examples for that okay.

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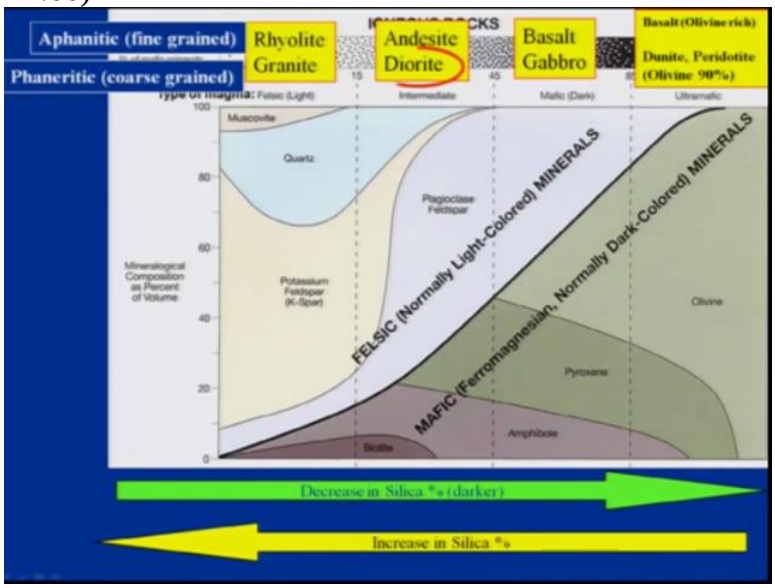

Then, we look at the diorite okay. So we are looking at the phaneretic coarse-grain rocks. So how the diorite looks like okay.

Diorite is an intermediate rock grain. So we are having the white part is mainly the plagioclase feldspar. And then we are having the darker ones are amphiboles okay. So it looks like so it is comparatively lighter.

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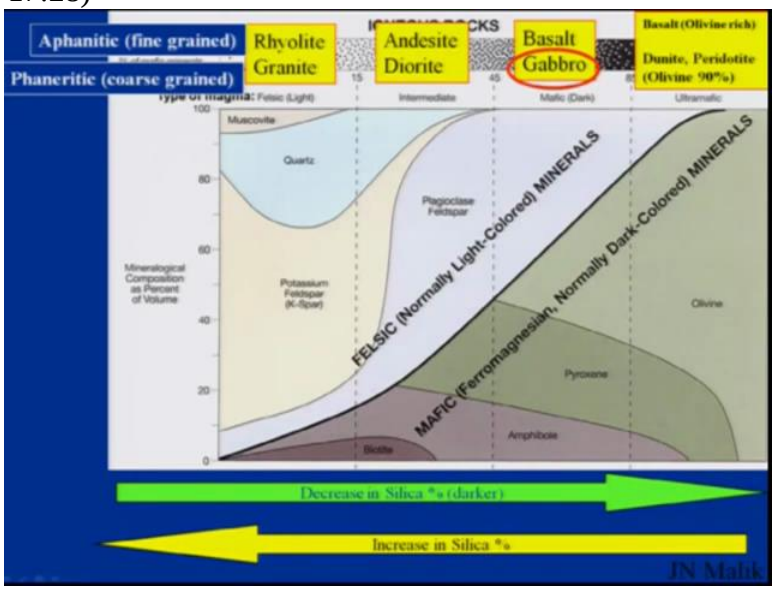

Then we are having the gabbro.So as we are moving towards the towards the right then there getting into the mafic rocks okay. So we are having felsic and mafic. Now you can look at the

gabbro. It has compare comparatively it is darker in colour and the composition what we see is again the feldspar is there, plagioclase feldspar and darker ones are amphiboles okay. So percentage of silica will reduce here. Whereas the ferro-magnesium minerals will increase okay.

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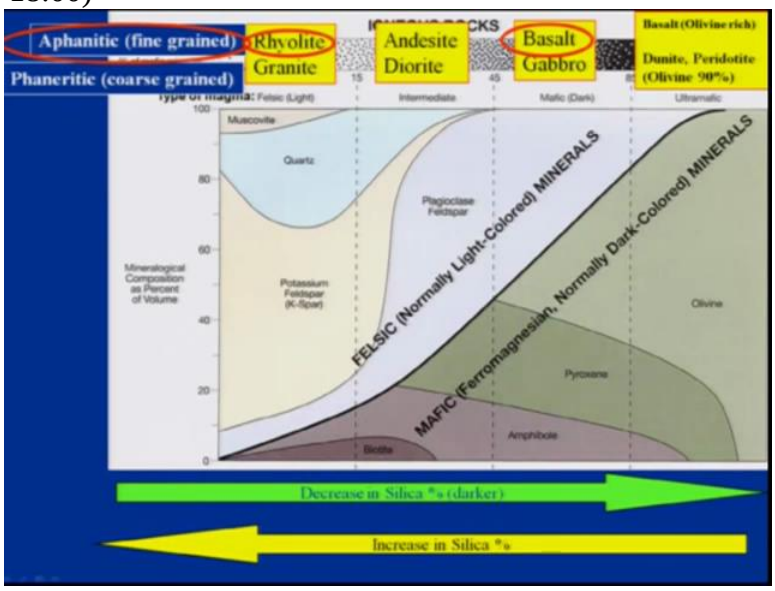

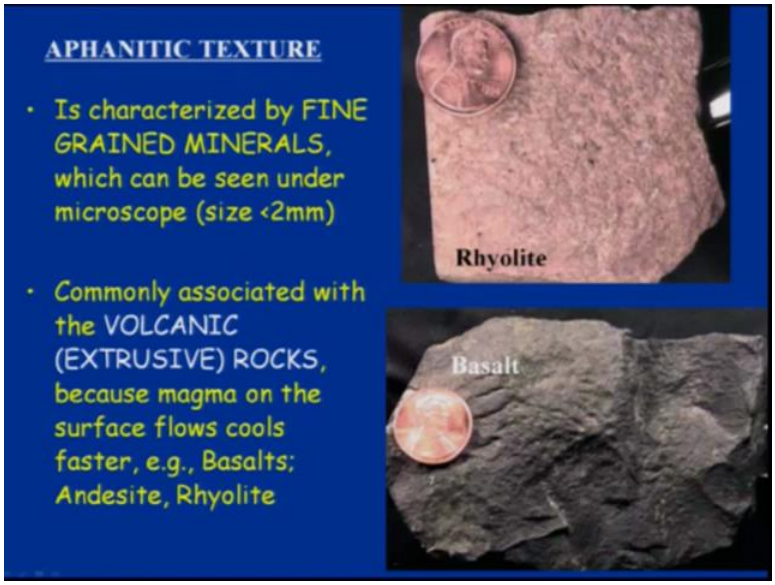

And then we are having the aphanetic fine grain rocks. We are having rhyolite. So let us see how rhyolite looks like and basalt okay. We will create both together and try to see okay.

So aphanetic texture is characterised by fine-grained minerals which can be seen under microscope because the size is less than 2 mm or okay. So commonly associated with volcanic

we say. So those were the plutonic and this is volcanic, extrusive rocks because magma on the surface cools faster and results into the formation of very fine crystals okay.

Example is basalt, andesite, rhyolite. So this is a rhyolite which is comparatively lighter in colour, rich in Felsic minerals and basalt is darker in colour, more rich in mafic minerals. Again basalt we see it is fine grain and this is also fine-grain.

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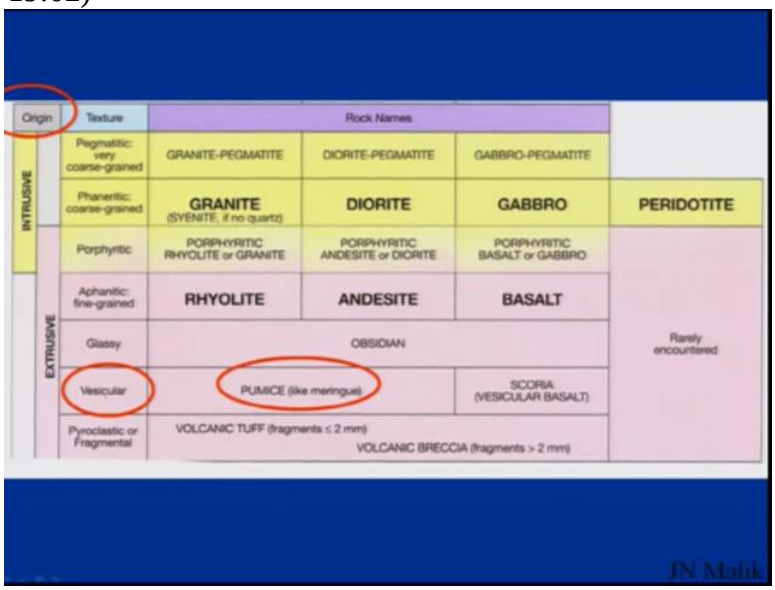

So origin and then if we take the texture that is an extrusive rocks if you look at, the vesicular nature okay or the texture, then we have Pumice okay. This is comparatively very light rock which is having these the cavities within it okay.

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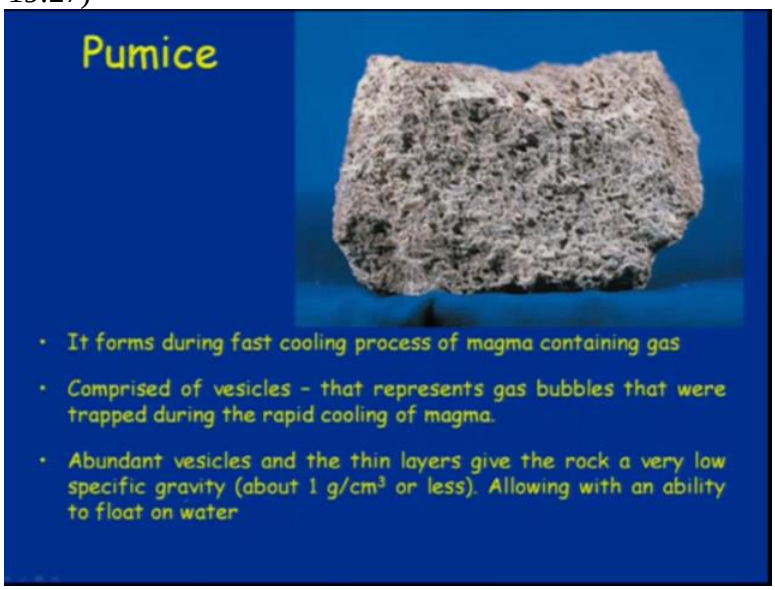

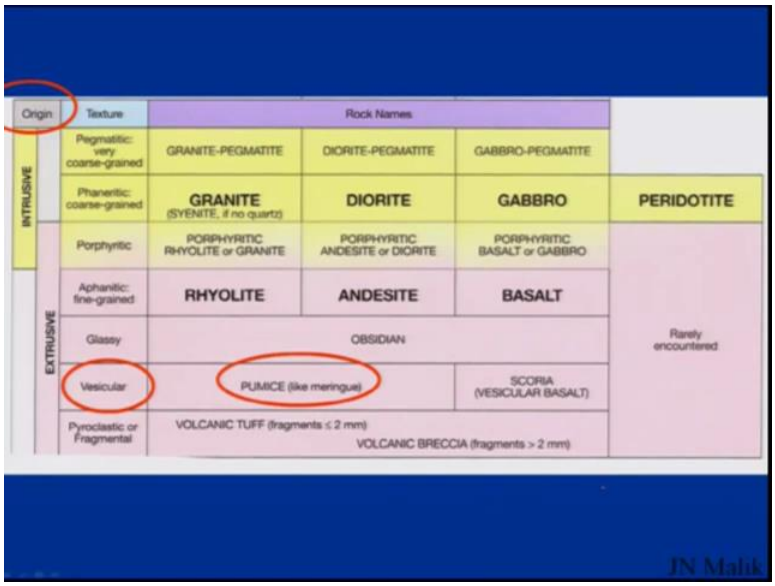

So this is this is again cavity is very light in comparison with the other. So it is it forms during the fast cooling process of the magma containing gases okay. So the gas the eruption or the removal of the gases will result into the left out pores what we call the vesicles okay. So compared of comprised of vesicles that represents the gas bubbles that were been trapped during the rapid cooling of magma. So when they are released, they will result in the left outs are the vesicles.

Abundant vesicles and the thin layer gives the rock a very low specific gravity which is less than 1g okay. So this is again in very lighter rocks allowing with an ability to float on water. So this is one of the very important characteristics of the Pumice which is we termed as an vesicular rocks okay. And this is an extrusive rock.

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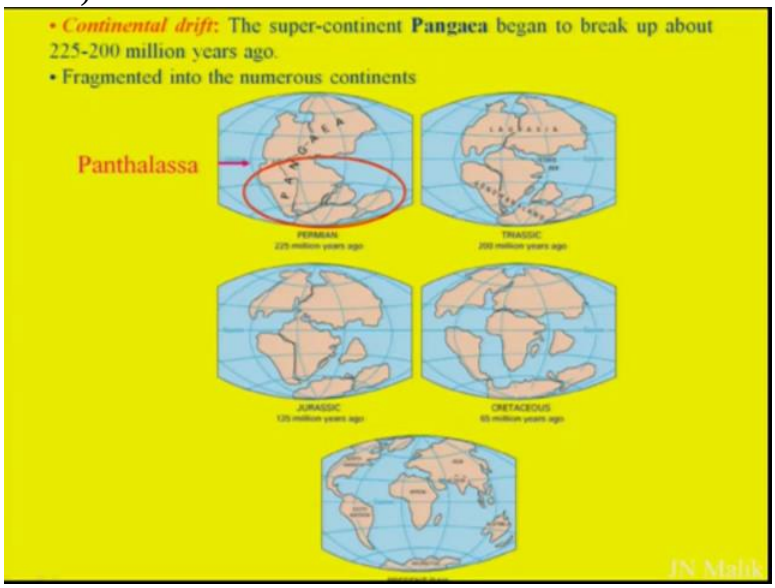

Now this just to look at that where exactly this type of rocks were been formed and then most important part here what we are going to talk is that why we are having so many or so much of area which is covered by your volcanic rocks in India. Why we see the Deccan plateau which is comprised of volcanic rock okay. And what was the reason? Because we do not have any volcanic eruption right now but probably had in the past okay.

So if you remember, we talked about the plate motions and all that and then we talked about that the earlier all players were together and finally they departed from the landmass which was known as Pangaea and then the Indian subcontinent particularly, it moved from the South of the equator and reached north of the equator. So during this journey, probably it came across the process of volcanic eruption and that what that is one of the reason why we are having the volcanic rocks in India okay.

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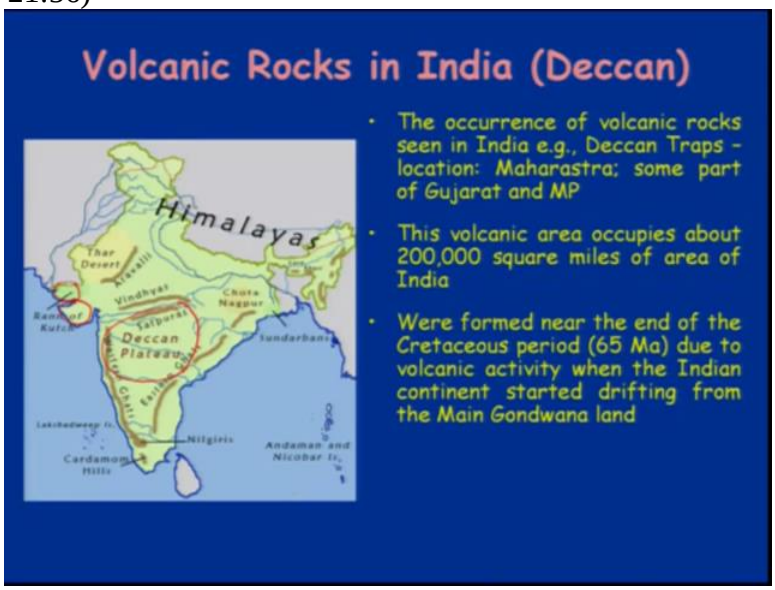

So let us see and try to look at what, why we are having the volcanic rocks in India what we call the Deccan region okay. So if you look at that the larger area of the Indian sub continent is occupied by the Deccan plateau which is comprised of volcanic rocks. Even we have few in Kutch region also and in this region also we are having lot of volcanic rocks okay.

So the occurrence of volcanic rocks seen in India in example the Deccan traps locations in Maharashtra, some parts of Gujarat and MP. And this volcanic rock occupies almost 2 lakh square miles of the area in India okay. So very large area is been occupied by the by the volcanic or the igneous rocks we can say. So this igneous rocks were formed near the end of Cretaceous period okay.

That is around 65 million years ago due to volcanic activity when Indian continent started drifting from the main Gondwanaland okay. So the main Gondwanaland was located like it was being suggested that the main Gondwanaland was the area which was been occupied.

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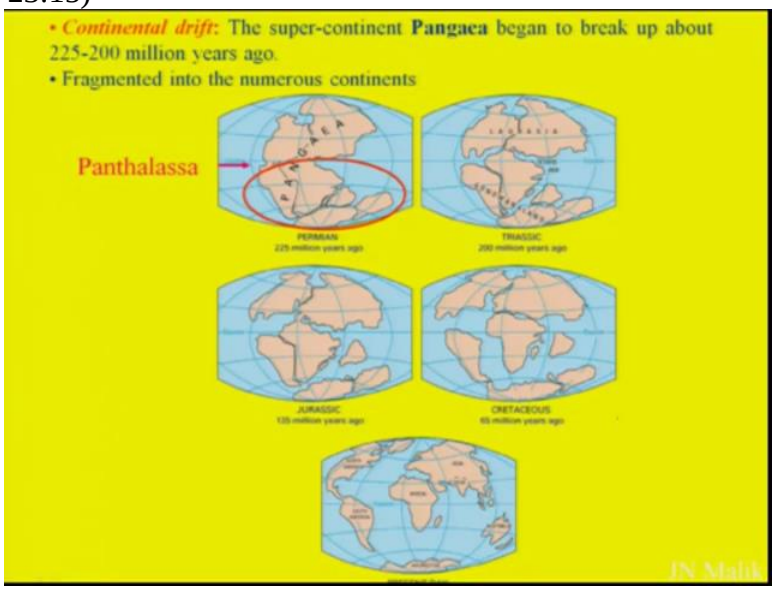

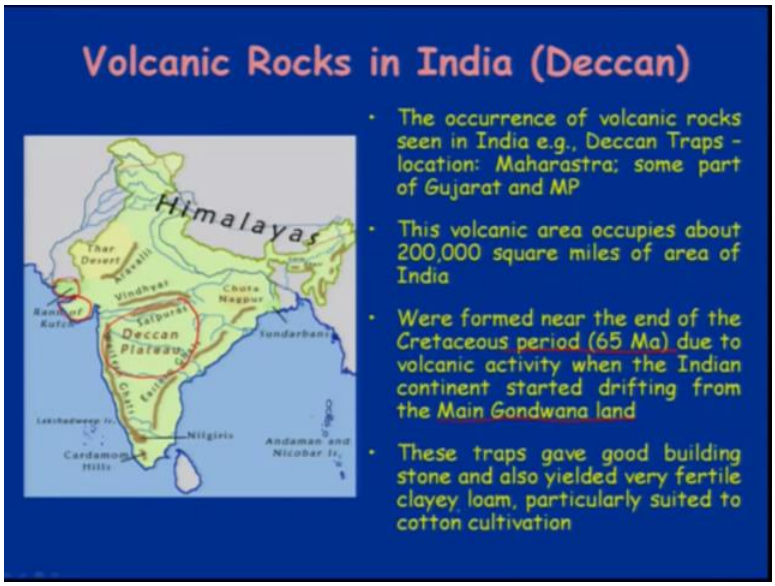

So this was the main Gondwanaland. This is what we see okay. So when it started drifting from here, it came across it it it it experienced the volcanic activity during that period and it was almost like 65 million years back okay. And this is what we call traps and these traps gave good building stone okay. So if you see that this is being used at various places okay. And also, it gave us a very fertile clayey loam particularly suited for cotton cultivation in this particular region.

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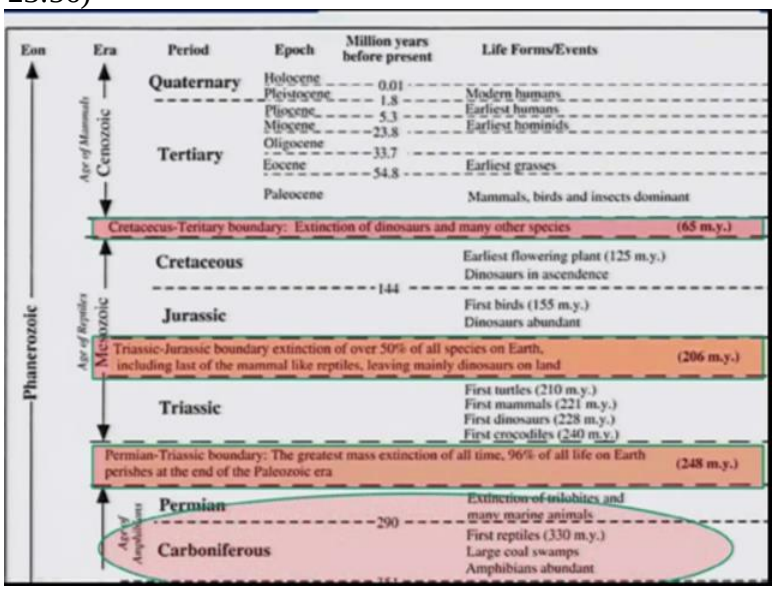

Now just to see that what are the different type of what what this this we have already discussed but I will just move very fast that the events, different events, now these are all events which are which are been related with the with the volcanic eruptions okay. So Permian Triassic boundary was the major event almost like 248 million years back.

And then we are having Triassic Jurassic boundary which is around the event again was related to the eruptions and the major species were been like the extinction of major species during this period also. And then we are having Cretaceous Tertiary boundary which is around 65 billion years back okay. So we have these are the events which are again probably were been related to the major eruptions in the region okay.

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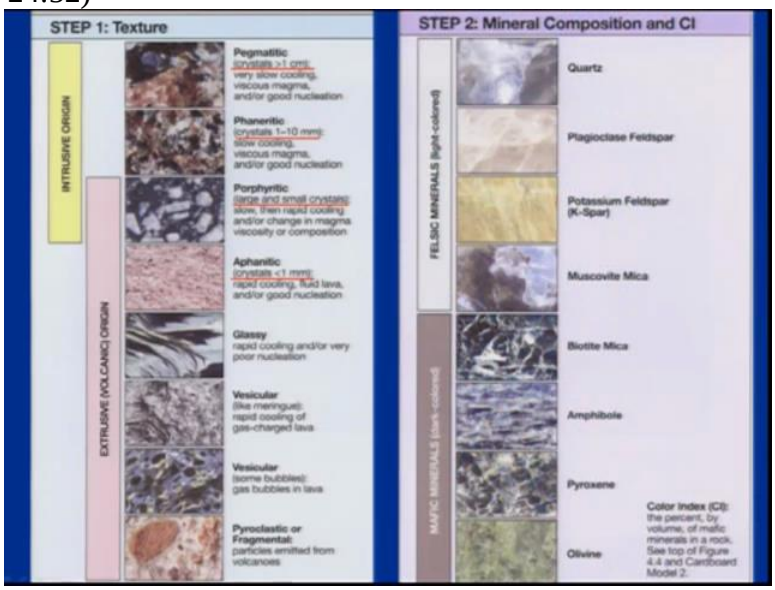

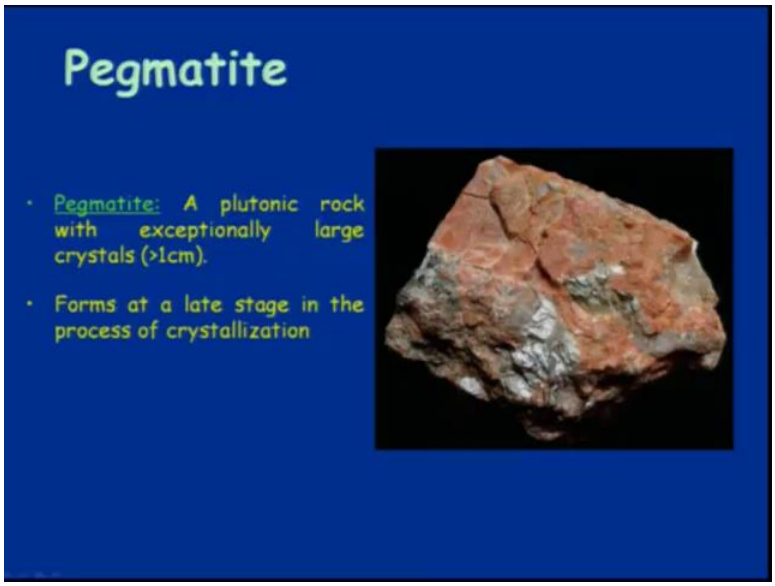

Now coming to the texture again and then we look at this examples of the pegmatites and phaneretic and porphyritic texture. Let us see this one okay. Again, the pegmatites. So we are having very large crystals. Again they are these are the plutonic rocks and having the crystals greater than 1 cm. So it looks like something like this okay. So what we are having, it forms at the late stage in the process of crystallisation okay.

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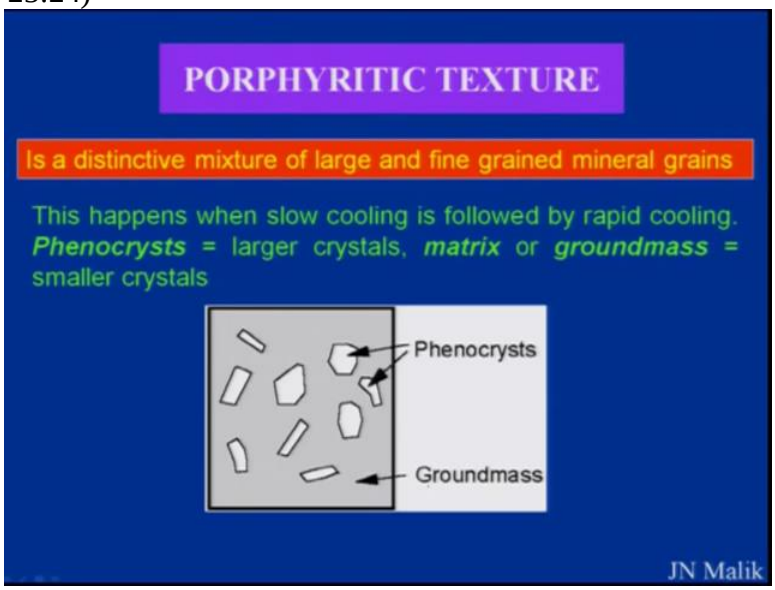

And then we are having the porphyritic texture. It is a distinct mixture of large and fine-grained minerals okay, together. So this happens when slow cooling is followed by rapid cooling. So phenocrysts are termed as like larger crystals are termed as phenocrysts and the matrix which is the ground ground mass are the smaller crystals. So we are having larger crystals and we are having the finer ones which are termed as the ground mass.

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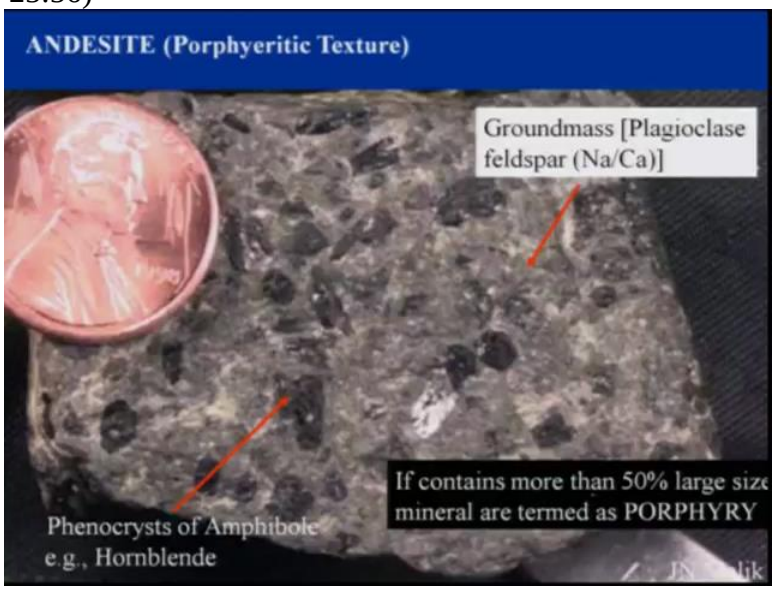

And then we look at the andesite and the andesite is mostly what we see is the porphyritic texture okay. So we see the larger ones which are phenocrysts and the smaller is your ground mass okay.

So mostly the hornblende crystals are been seen and then ground mass is mostly the cals sodium and cal calcium caclic feldspar okay. So that is a ground mass okay.

So if contains more than 50% larger minerals, then they are termed as porphyry okay. This is another term which has been given to the rock based on the texture that it comprises or contains 50% of larger crystals okay. Then they are termed as porphyry. So this is an example of andesite porphyritic texture.

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Then volcanic rocks like glassy which we see is one of the best example is the obsidian. And this is because the rapid cooling of lava causes minerals to form tiny crystals or glass like shape. So this is the one of the examples for the rapid cooling.

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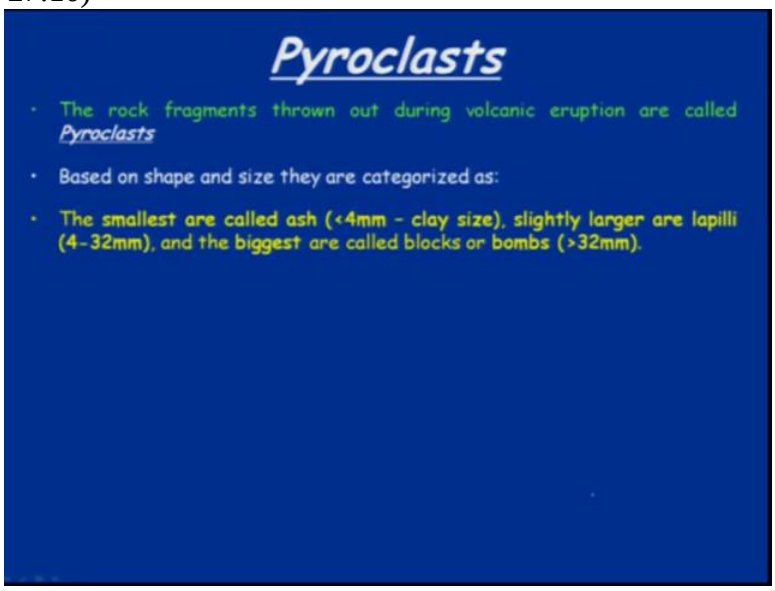

Then we are having pyroclasts and these are mostly related or been seen or observed during the volcanic eruptions okay. So this is, this comes, the rock fragments are thrown out of volcanic cone during the time of eruption and they and based on this the most of the volcanoes are also classified whether the volcanoes are having the capability of putting ash during the eruption or they are having the characteristic of putting out the pyroclast okay.

So we say pyroclastic flows or it is having the lava flow only okay. So this will be ejected on in the atmosphere okay. So based on the shape and size, they are characterised as the smallest are called ash which is having the less than 4 mm or the clay size. And then we are having slightly larger are termed as lapillis which range in size from 4 to 32 mm. And the biggest are called as bombs which are greater than 32mm. So all this can be classified as a pyroclastic flow okay. So thank you very much. We will continue in the next lecture.