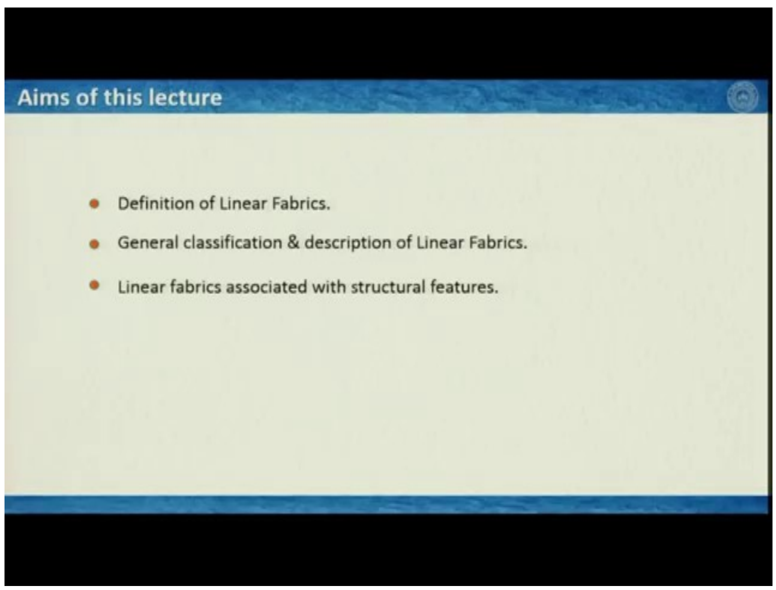
Structural Geology
Professor Santanu Misra
Department of Earth Sciences
Indian Institute of Technology, Kanpur
Lecture 19- Linear Fabrics (Lineation)

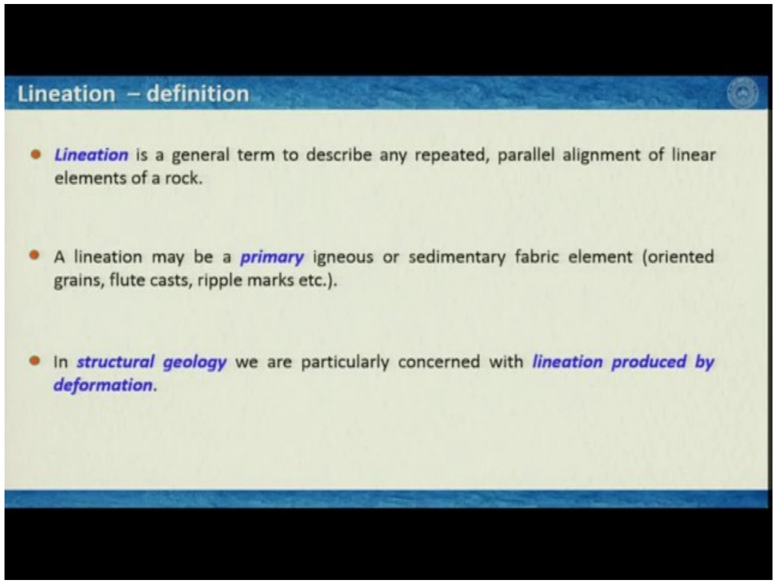
Hello everyone. Welcome back again to this online Structural Geology NPTEL course. And today we are in our lecture number 19 and we are learning foliation and lineation-linen and linear fabrics. And we are at the last lecture of this week and we will learn lineation today.

(Refer Slide Time: 00:50)



So, the topics we will cover. We will first define the linear fabrics. Then we will classify lineations and try to provide some sort of general descriptions of linear fabrics. And then we will mostly look at some special types of linear fabrics or lineations, associated with most of the structural features and what are their uses and so on.

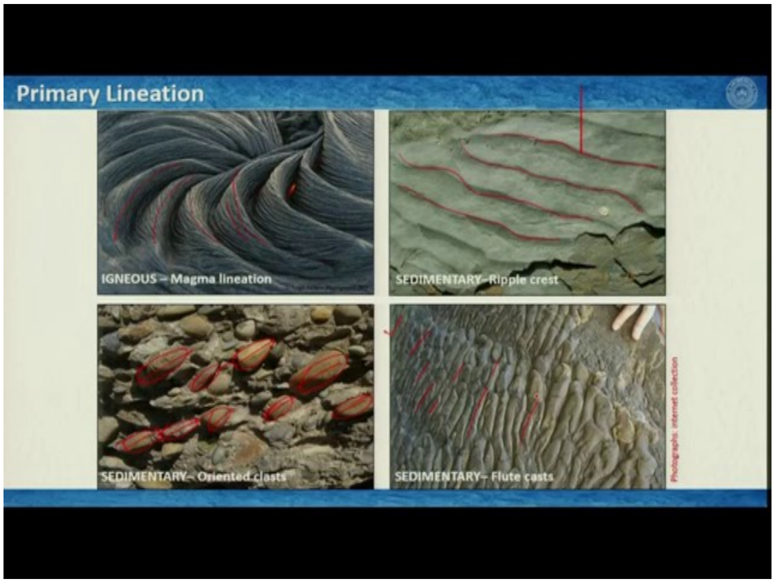
(Refer Slide Time: 01:02)



So, lineation as it is defined is a general term to describe any repeated parallelly aligned linear elements in a rock. And as we have defined foliation, lineation is also something that has to occur homogeneously in the rock system and at the same time penetratively. But there are few, a few special types of lineations which are not penetrative. We will consider this as a special case. And lineation like foliation, so we talked about could be-primary and essentially secondary which are formed due to the deformation.

So the lineations which are primary, these are mostly as we have learnt for foliation as well. It could be igneous or sedimentary fabric element. So these are mostly defined by oriented grain, flute casts, ripple marks and so on. We will have few photographs to show you. But in structural zoology as we deal with the deformed rocks, so we particularly are interested and concerned with the lineations which are produced by deformation.

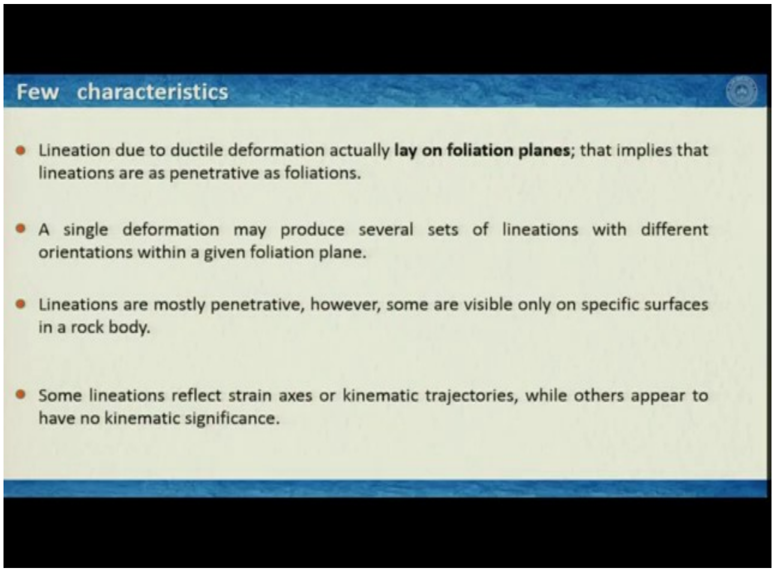
(Refer Slide Time: 02:24)



And if we talk about a primary lineations, then here are some examples. So in igneous rocks, you can see lineations due to magma flow. So you see that series of linear features are being developed here due to the flow of magma. Then in sedimentary rocks there are series of different lineations, which are of primary origin. Say, these are the ripple marks. So crest of the ripples, you can consider them as a linear feature or a linear fabric.

Then oriented clasts, so for example, if you consider all this clasts and statistically if you try to figure out, so their orientations give you a kind of lineation in the rock. And some sedimentary features like flute cast and so on, which you see in this illustration, these are also considered a kind of a primary lineation. But as I said, we will mostly deal with lineations associated with deform rocks. So we will directly switch to that.

(Refer Slide Time: 03:29)

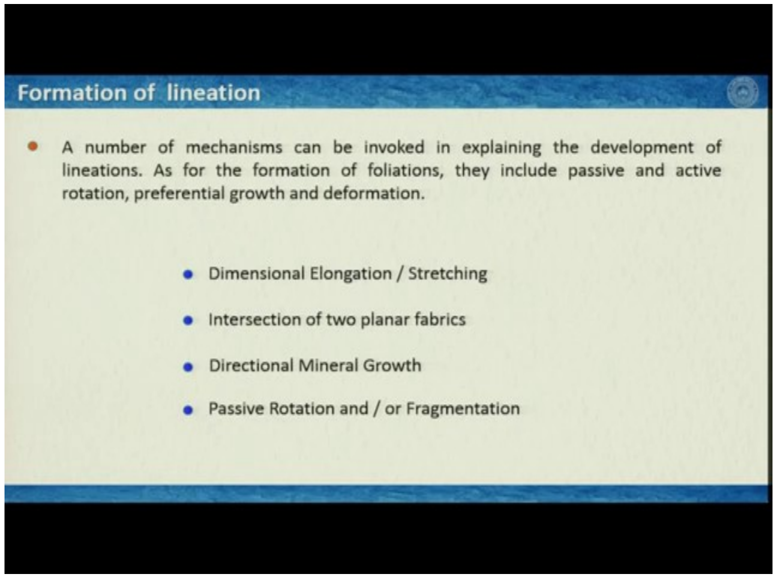


But before that will look at some of the characteristics of a linear feature in deformed rocks. So what is very interesting is that lineations that we see in the deformed rocks or lineations which are produced during ductile deformation, they actually lie on a foliation planes. So if I have to find a lineation, I have to see them on the foliation planes. Or if I try to measure or take some structural information out of these lineations, I have to find them and then interpret them when they occur on the foliation planes. In any other sections, they do not provide any meaningful information.

So it also implies the fact that the lineations are therefore as penetrative as foliations. Now a single deformation in case of foliation, it produces mostly a single set of foliations. But in case of lineations, a single deformation may produce a number or a series of sets of lineations with different orientations in a single foliation plane. So this is very interesting. We learn about it soon.

Then lineations as I talked about, they are mostly penetrative, if there in, if there forming in the ductile manner. However, there are some special types of foliations. They are visible only on specific surfaces in a rock body. Some lineations are excellent in characterizing or in interpreting the strain axes or kinematics trajectory. And there are few, they just remain as lineations and they have virtually no relationship or no kinematics significance with the overall strain of this region.

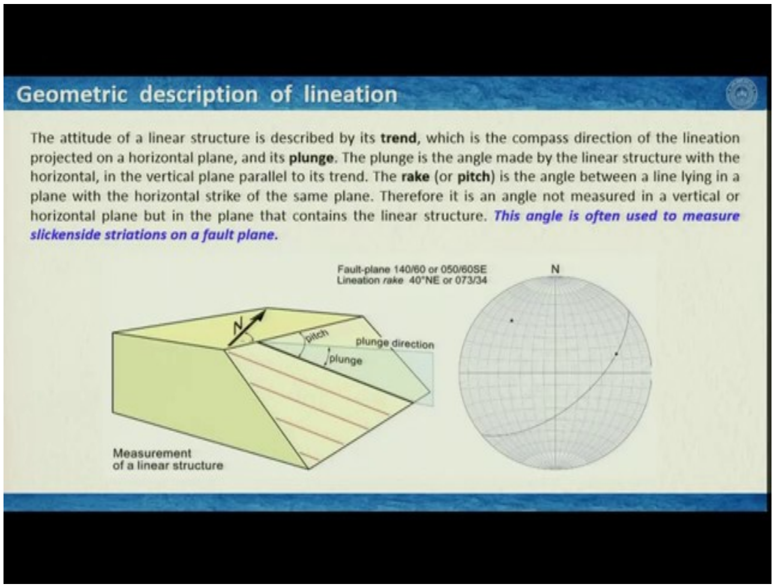
(Refer Slide Time: 05:24)



So with this context, we will see that the lineations, therefore generally can form in four major ways. So there are many mechanisms you can think of that explain the development of lineations. But if we consider the formation of the lineations, mostly they are formed either by passive manner or by active manners. And these are listed here. So, one is essential dimensional elongation or stretching.

Second one is intersection of two planar fabrics. If you remember in our stereo net lectures or dip strike lectures, we define that a line can be defined by two intersecting planes. So it is exactly this one. We will see. This is known as intersection lineations soon and then directional mineral growth. And of course, this is formed by passively. So, passive rotation and or fragmentation of mineral grains or some oriented layers. So, these four are the basic mechanisms of the formation of lineations.

(Refer Slide Time: 06:28)

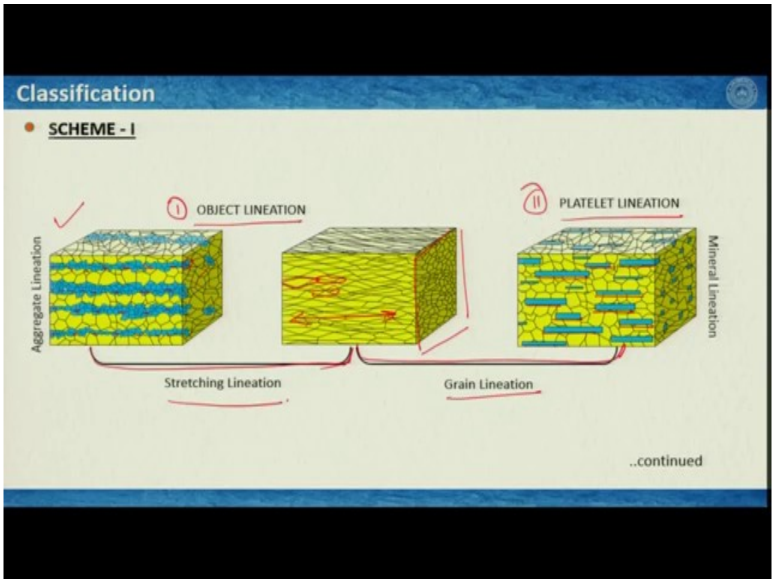


Now, this we also have learnt. I just wanted to review that this is a plane. And in this plane if I consider this as a plane and if this is north and if these are linear features, then this angle this, that you measure on vertical plane is a plunge of the lineation. Then with respect to north, so if this is north, then if you measure it horizontal plane, this is the trend of the lineation.

And if you measure this angle of the lineation on this plane itself, then gives you pitch or rake. So in summary, the attitude of a linear structure is described by its trend which is the compass direction of the lineation projected on a horizontal plane and its plunge. The plunge is the angle made by the linear structure with the horizontal in the vertical plane parallel to its trend. And the rake or the pitch is the angle between a line lying on a plane with the horizontal strike of the same plane.

Therefore, it is an angle that you do not measure on the vertical or horizontal plane but on the plane that contains the linear feature. And this angle sometimes is often measured mostly to figure out the slickenside striations on a fault plane and so on. And for example, in this case, if this is the north then we can figure out. So this is the linear feature and this is how we plot it in the stereonet, okay.

(Refer Slide Time: 08:17)



Now, to classify lineations, I must say that there are number of schemes in classifying lineation. So, I will show you three different schemes. And I will also tell you that these schemes are mostly based on the, based on some practical purposes, the way you define it. But each and every type of lineations has their own characteristics. However, as geologists or as structural geologists, we try to group them together to better understand their behavior and mechanics and also their descriptions.

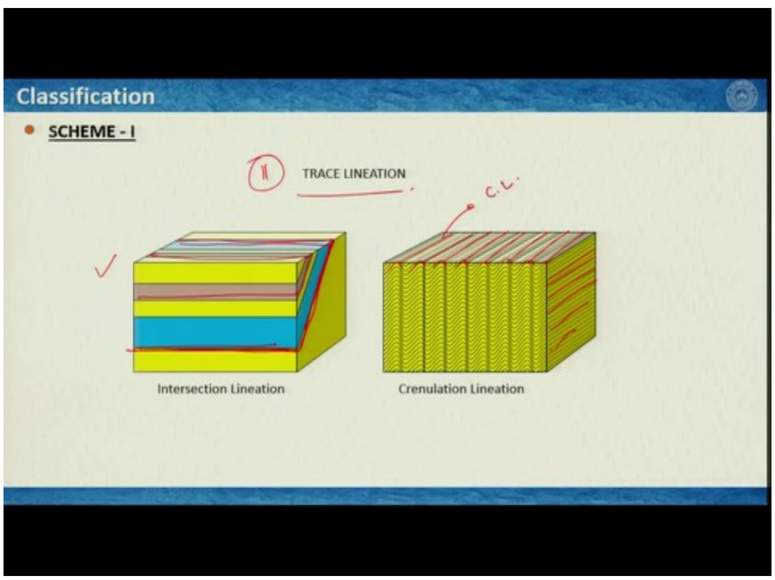
So in scheme 1, we generally classify them in three different categories. One is object lineation. Second one is platelet lineation and in the next slide we will see third one, is a trace lineation. So in the object lineations that defines that the grains or the minerals, they are objectified to define the lineation. So, the first one in this diagram is the aggregate lineation, that means aggregation of minerals do define the lineation along a certain direction.

Now, I have given this in three dimensional block diagrams, simply because you see that on this plane, this orientation of this fine grain blue crystals are defining your lineation. But on this plane, you see that these are not continued. So these are like this. So you can imagine that you have a block. And in this block, you have inserted a series of cylindrical rods or so on. So if you insert planes, then it would become foliation. But if you insert some rods, then it is lineation. And if you can imagine, the rod is actually aggregate of some fine grain minerals or so on. Then this is aggregate lineation and this is an object lineation.

Here in this case, we see that at least in this plane, these crystals are oriented along this direction. So this orientation of these crystals is defining the lineation here. Again you see, on this face there is virtually no fabric or no directional features here. So again these are just some oriented grains and they are oriented along a particular direction or they got stretched along a particular direction. Therefore, these two object lineations are also club and said stretching lineation.

Now in the platelet lineation, what we see that some minerals, they grow or they appear there as elongated features within the matrix. As we can see here, the blue grains are defining this. This could be mostly mica and so on. And these are defined by a single grain or a cluster of grains. And therefore, these are known as grain lineation.

(Refer Slide Time: 11:42)



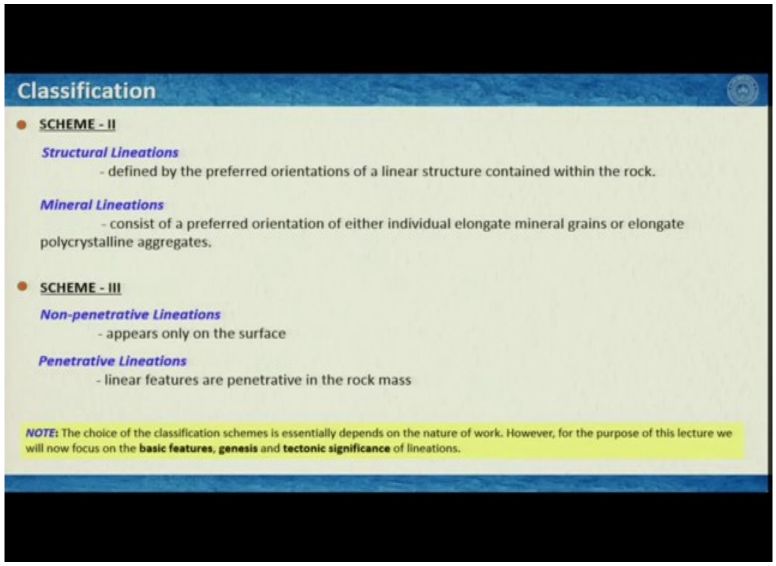
And if we go to the next slide and continue the scheme 1 classification as I talked about, the third one is the trace lineation. So here these are mostly intersection of different planes. And this intersection defines the lineation. So in the first block diagram, what we see here, again the same block. And we see this blue and this little lighter brown two layers. So, this one and this one, you can imagine that these are bedding planes which are inclined.

So in this plane, you can consider this as a lineation. And this lineation is the intersection between this yellow plane and this bedding plane. In this plane as well, we can consider this line as an intersection lineation. And this plane as well, we can consider this line as an intersection lineation. And these are sometimes very important in figuring out the orientation of the actual bedding plane. So you have this lineation. You have this lineation.

And you, and by using the stereonet, you can figure out what is the dip and strike of the plane, of this blue plane here. Now crenulations lineation is something that is defined by the axis of the crenulations. So for example here, this in this illustration what I try to show here that this area or this block is highly crenulated as it shows. You can consider this as intersection lineations. However, the hinge of this folds here or troughs of this fold here, they are defining on this surface. So these are known as crenulation lineation.

And this is how we define in Scheme 1, this object lineation, trace lineation and the second one that we have discussed here, platelet lineation. So object lineation, mostly are defined by some aggregation of grains and so on. Platelet grains or platelet lineations are defined by the oriented individual grains. And then finally, this is number 2. And finally the number 3 – trace lineations are defined by mostly intersection of two different structural features or geological features.

(Refer Slide Time: 14:28)

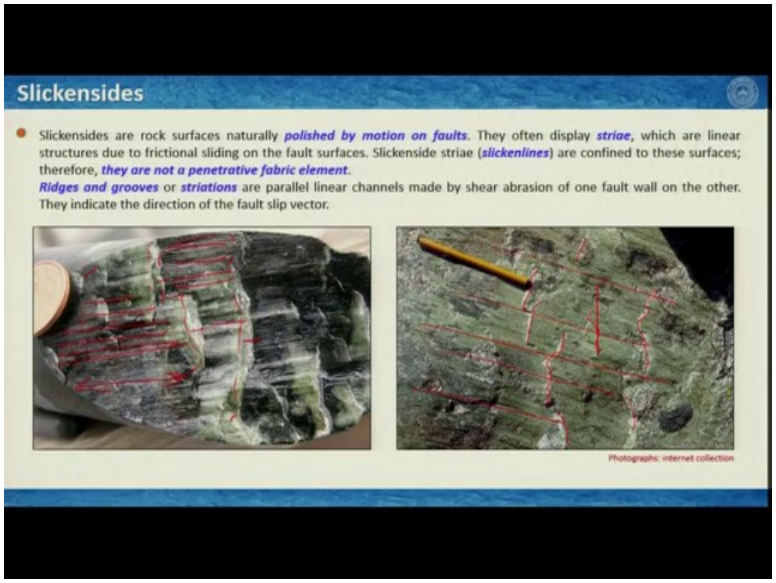


And then in scheme two you can figure out, you can define it is as structural lineation and mineral lineations. So, structural lineations are defined by the preferred orientations of a linear structure contained within the rock. And mineral lineations consist of a preferred orientation of either individual elongate mineral grains or elongate polycrystalline aggregates. So you can see that these two are more or less similar scheme of Scheme 1. But some people prefer to define or describe lineations, classify lineations in this way.

And in the scheme 3, it is very straight forward non-penetrative lineation and penetrative lineation. So, non-penetrative lineations, when you see them only on a very specific surface. And penetrative lineations, they generally are present everywhere in the rock and therefore, they are penetrative. Now the choice of this classification schemes essentially depends on the nature of the work.

As I said that it is based on essentially how you are seeing them in the field and how you are observe them and how you would like to describe them. Now in this lecture, I am not going to follow any of this classification schemes. What I try, that I will try to give you some sort of basic ideas of the lineations. Their basic features, genesis and at the same time their tectonic significances.

(Refer Slide Time: 16:08)



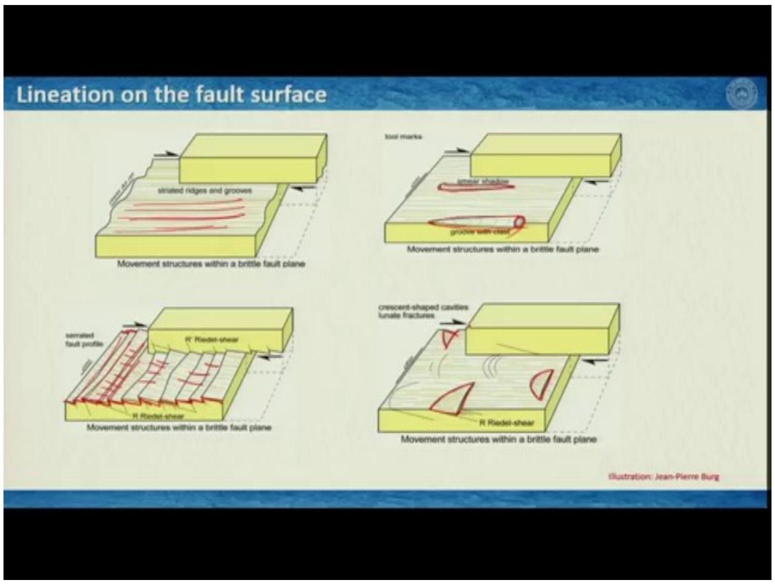
So, let us first have a look of one non penetrative lineation. And these are known as slickensides. So slickensides are rock surfaces naturally polished by motion of the faults. What happens, if you have a fault going on. On the fault plane when one block move past the other block, then on this surface the one block rubs the other surface. And the rub; and this rubbing happens along a particular direction.

And due to this rubbing, this surface is characterized by a number of lines. And these lines are known as slickenlines. And slickenlines, because it happens only one surface or a series of surfaces in a very narrow zone, they are confined to the surfaces. So therefore, they are not a penetrative fabric elements. And these slickensides are mostly characterized by ridges and grooves or striations.

And they are parallel to each other. So these are fine linear channels made by shear abrasion of one fault wall with the other. And they also indicate the direction of the slip vector. For example, if we see here, we see that these are different planes. So this is one plane, then this is another plane, this is another plane and so on. So, successive steps are there, but this happened in a very narrow area. And you see this striations.

So, these are you slickenlines and these slickenlines also indicate the fault slip happened along this direction. And here as well, they are characterized by this orientation. So you can figure out this is a lineations. And then there are some steps. And these steps are very-very important to figure out what is the actual vector. The way or the direction the fault plane has moved past the other plane.

(Refer Slide Time: 18:07)



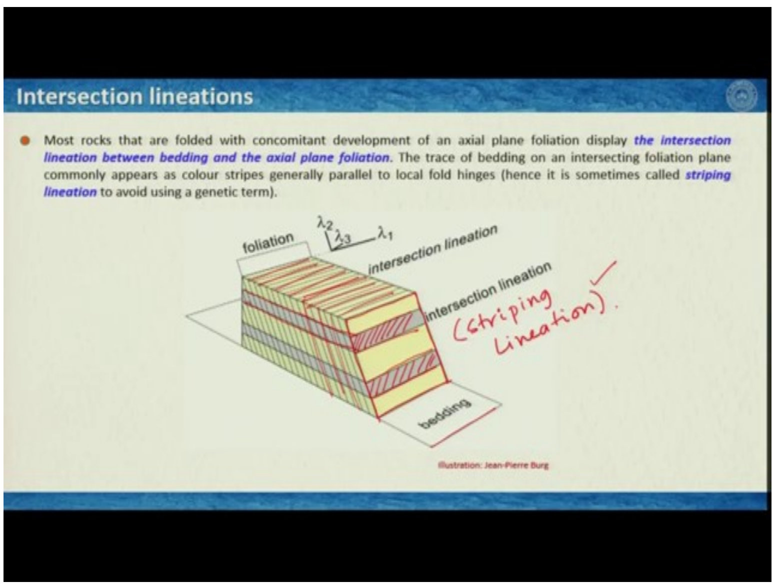
Now on the fault surface as we talked about, that it can be characterized by many different ways. Here are there four schematic illustrations. So, one is very simple as we have seen in the previous image. So it is the movement of structures within the brittle fault plane. So you only found a striated ridges and grooves, like alternating very-very fine ridges and grooves.

And if you have some sort of clast or something like that a broken pieces, a broken piece on this fault surface, then this also gets drag. And then you generate something, which is called smear shadow or groove with clast. This is also possible to visualize in the field, if you are lucky. Then fault planes are also characterized by number of shear fractures. So riddle shear fractures is one of them.

And if they perform the step like features, we will learn about riddle shear fractures in our fault lecture. But they are generally formed if they are connected to each other, then they form this like steps. And these are also characteristics of lineations. And you can also figure out that the lineations should form in this direction. And you can also form some sort of crescent shaped cavities or lunette fractures. So they are, they appear like this.

And they also indicate, what was the direction of the fault movement? So, these four are very important. Not necessarily, you see all of them on a single fault surface. But in different fault surfaces, based on their kinematics, based on their mineralogy, based on the morphology of the fault surface itself, you can get these features either in the single plane or in different planes. So with these we finish the surface lineations or non penetrative lineations.

(Refer Slide Time: 20:24)

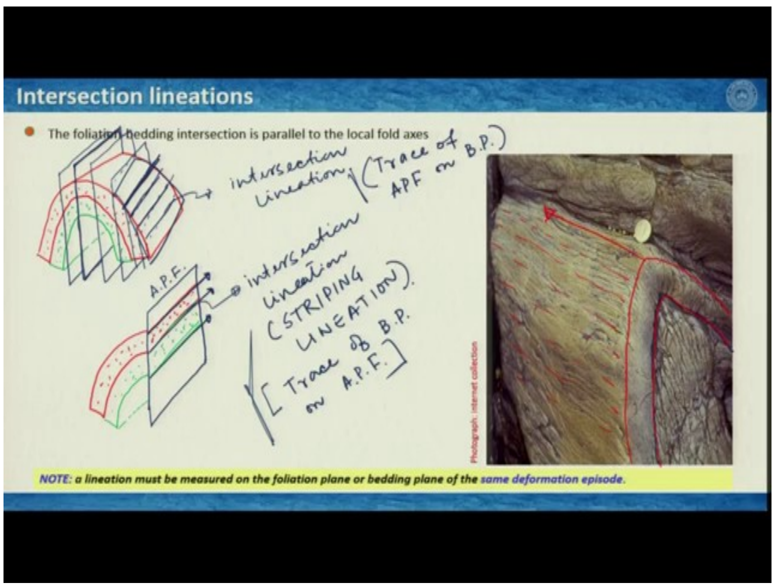


So we now switch to the penetrative lineations and we first start with the intersection lineations. Now, as I have described before that intersection lineations are nothing but intersection between two planes. So most rocks, which are folded, particular we see in folded rocks in low grades with concomitant development of an axial planar foliations, they display this intersection lineation between bedding and the actual plane foliation.

The trace of the bedding on the intersecting foliation plane commonly appears as color stripes generally we call it a striping lineation. And this is something very interesting. So what we see here, that if this is the bedding plane, the orientation of the bedding plane defined by this. So this grey layers here, these are your bedding planes. And the foliations are oriented like this. Now this is your foliation plane.

On this foliation plane, the bedding planes appear like stripes. So therefore, this is known as intersection lineation or striping lineation. However, on this surface, which is parallel to the bedding plane you see only the intersection lineation. So intersection lineation on the foliation plane would give you striping lineation of the bedding planes. And intersection lineation on the bedding plane would give you the traces of the foliations itself that defines the lineation.

(Refer Slide Time: 22:25)



Now, this has a very interesting significance with the fold morphology. So, how does it work? We will look at this image later. But let us figure out the fact that if we have a fold like this, let me draw it with two different colors. So if this is the fold, then the foliations or actual planar foliations, as you can guess would be a plane like this, okay. And there would be series of such planes isn't it.

And so on. So these are your axial planes. And these axial planes would cut or would touch the bedding planes. So, on the bedding plane, if I figure out, so there would be the series of traces of these foliations. So these are your intersection lineation. Now, if I take, for example, this plane and wipe the and cut it in halves. So therefore, it should look like, that means I have this plane here, the same plane. And then I have this red layer folded. And of course, I also have the green layer folded. Now what would happen on this plane?

This is your foliation plane, isn't it? This is your actual planar foliation. Now in this foliation plane, the red layer would appear like this. And the green layer would appear like this. So this is also intersection lineation, this line, this line and so on. But these appear as striping lineation. And here, these are your the trace of the lineations. Now we see that the trace of axial planar foliation on the bedding plane, in this case, if we measure their orientations.

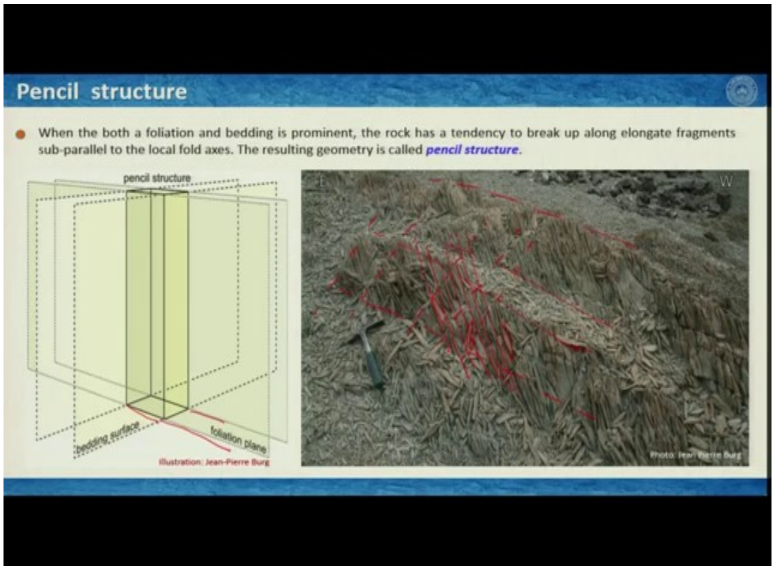
So this is trace of axial planar foliation on bedding plane. And this is trace of bedding planes on actual planar foliation. What is important here that in both cases, they would if you can measure their trend and plunge, they would give you a similar orientation. So if you measure intersection lineations trend and plunge in this case, and if you measure intersection lineations or striping lineation trend and plunge in this case, their values would be absolutely similar.

We didn't learnt fold yet. But I tell you that doesn't matter whether you are measuring this or you are measuring this, they would always indicate the orientation of the concerned fold. But you have to measure them either this way or this way. That means the trace of the actual planar cleavage on bedding plane or the trace of the bedding plane on the actual planar cleavage.

Now, let us focus on this photograph, which I collected from the internet because this is spectacular. You can clearly see this surface is very much similar to this surface. So this is your bedding plane, right. Now on this bedding plane, these are your traces of this actual planar cleavage. And this keeps the orientation of the fold axis, we will learn about it later.

The summary of this slide is that intersection lineation between the bedding plane and the corresponding axial plane or cleavage gives you the orientation of the fold axis. So this is very important. But lineation must be measured on the foliation plane or on the bedding plane of the same deformation episode. So this is important. If you measure in different places, then you will not get the fold axial. You will get something else.

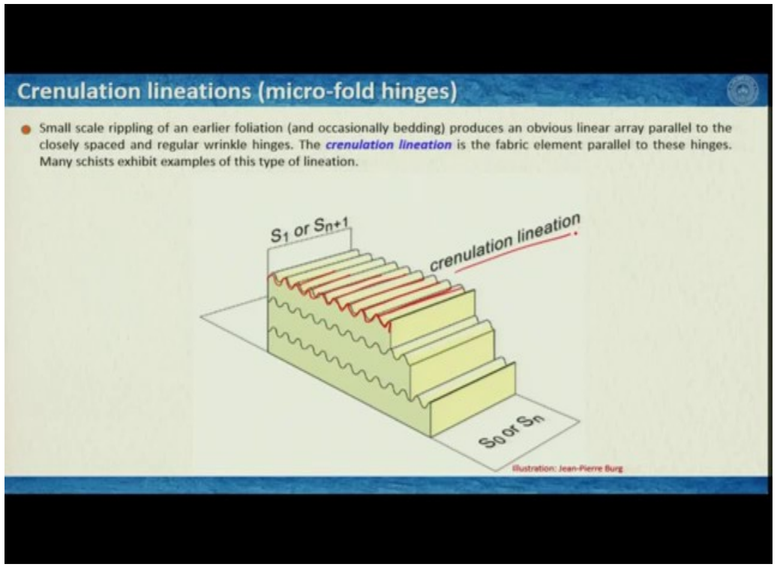
(Refer Slide Time: 28:57)



Now if this intersection lineation between bedding plane and the cleavage is very much intense or very much prominent, then what happens? Then you tend to break them up along some elongated fragments. As you can see here, you have bedding surface this one. And then you have foliation plane this one. So if they intersect them this way. If you, if you think of that you are chopping a potato, in one side like this and the other side like this. So one is your bedding plane, another is your foliation plane. The result is some long sticks of potato, which you make and which you may use for French fries. And these are elongated staff and these are known as in geological structures as pencil structure.

So as you can see here. In this photograph that some, lot of things are here. I am not very confident about the orientation of the bedding plane and so on. But this is certainly one of the orientations of the foliation plane. And this must be the bedding planes. And when they interact with the other way, you develop the pencil structure, which is a kind of lineation.

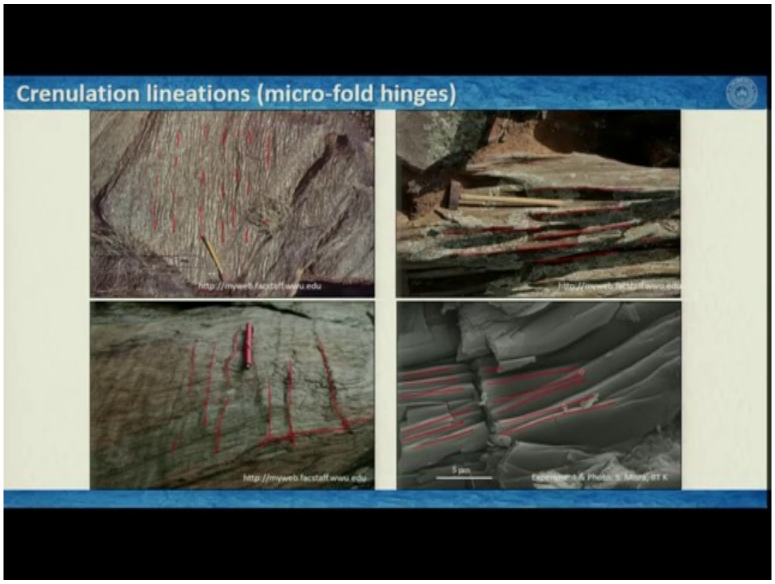
(Refer Slide Time: 30:31)



Now crenulation lineation, as we have learnt about it. So it is the lineation defined by the hinges of the micro folds. So small scale rippling on an earlier foliation and occasionally bedding very-very fine laminated, very-very fine thinly laminated bedding planes, they sometimes produce an obvious linear array parallel to the closely spaced and regular wrinkle hinges.

And these are known as crenulation lineation. The crenulation lineation is a fabric element parallel to these hinges. And most of the schist, they exhibit examples of this type of lineations. So crenulation lineations are mostly generation or the indicative the presence of the second stage of the deformation. As you can see here, these are the folds, micro folds and their hinge lines are defining a linear feature. And these are known as crenulation lineation.

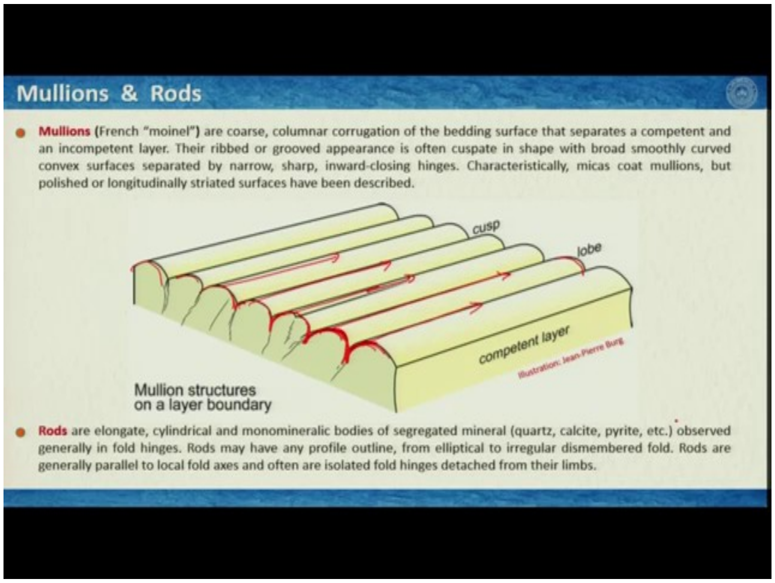
(Refer Slide Time: 31:42)



So here are some photographs, fill photographs and some photographs from scanning electron microscope. So what we see here? You see these wrinkles here. And these are your crenulation lineation. You can see this also in a different way, here in this image. Again these are your crenulation lineation. Here as well, you see this are some sort of asymmetric crenulations here.

And these are the hinges of this asymmetric micro folds. And they are also defining the crenulation lineation. This is scanning electron microscope photography of some experiments. And you can see the crenulations are there. And these are their hinges, hinge lines which are arranged parallel to each other and defining the crenulation lineation.

(Refer Slide Time: 32:53)

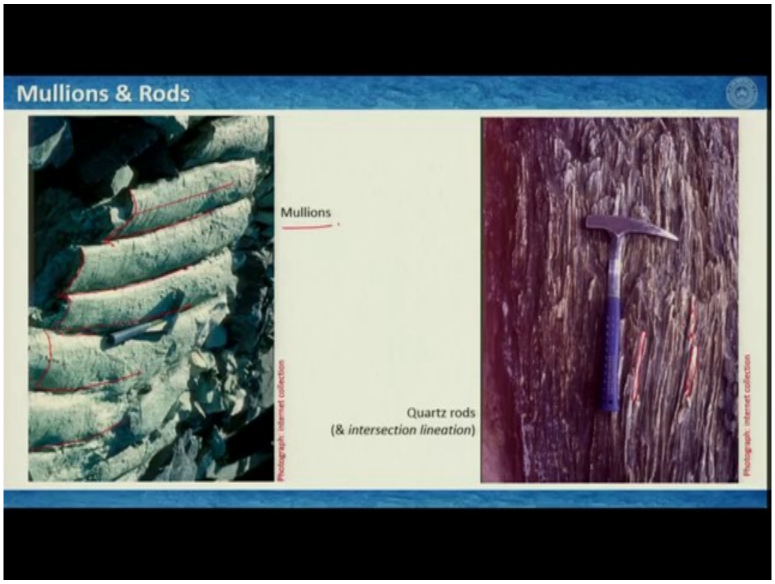


Now, there are two more important lineations which are associated with folds. One is mullions and another is rods. So, mullions are generally coarse or columnar corrugations of the bedding surfaces that separate a competent and an incompetent layer in a folded surface. So, their ribbed or grooved appearances is often cuspate is this one. And they generally represent the broad, smoothly curved convex surfaces, as you can see here.

And these broad smooth surfaces are separated by very narrow, sharp, inward closing hinges, this one okay. So this alternate round hinge and sharp hinge features, they produce in the third dimension a lineation and which is known as mullions. So we have cusp here. This hinge, narrow hinge and then we have lobe here, which is broad hinge. The rods on the other hand, they are elongate, cylindrical and mono-mineralic bodies of segregated minerals.

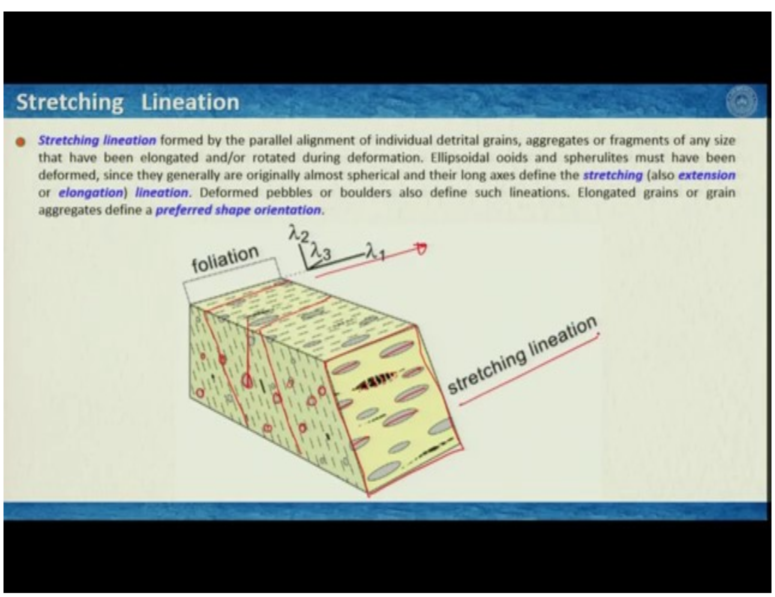
And these are mostly defined by quartz, calcite, pyrite and so on, these highly mobile minerals or highly; the minerals that can get highly dissolved. And these are generally observed in the hinges of the folds. And rods, they may have any some sort of a profile outline from elliptical to irregular features within the fold. And they generally at parallel to the local fold axis, their orientations and they often are isolated fold hinges, detached from their limbs.

(Refer Slide Time: 34:58)



So the mullions, they look like something like this. So you can see that these are lobes. This broad, wide hinges. And then we have cusps going on here, this sharp thing. And this, in third dimension defining a lineation, these are known as mullions. The quartz rods are something like this. They look like in the field. So these are the segregation of quartz and you can see very nicely the folds and so on going on here.

(Refer Slide Time: 35:46)

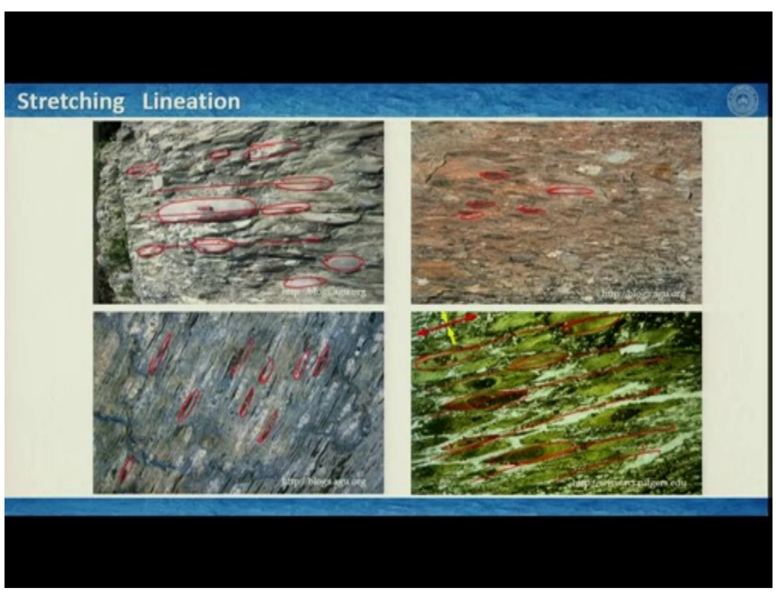


The stretching lineation is another type of a very special lineation and they are formed by the parallel alignment of individual detrital grains, aggregates or fragments of any size that have been elongated and or rotated during deformation. So that means that we have some random shaped grains in the pre existing rocks. And during deformation, these grains or these clasts, they got stretched or deformed along a particular direction.

And if that happens, then the deformed grains or clasts define a lineation. And this lineation is known as stretching or extension or elongation lineation. And sometimes these elongated grains or grain aggregates also define preferred shape orientation. As you can see here, this is the maximum stretching direction lambda 1, quadratic elongation. And therefore, you see that the grains are rotated, the grains are stretched in this direction.

Few grains, stiffer grains, they also are broken forming some micro budding and so on. However in this section, which is your lambda 2, lambda 3 plane, you do not have the stretching or anything. They remain more or less circular. And this is your foliation plane. And you can see that this lineation, if you talk about, this is the foliation plane. This lineation is on the foliation surface and this is known as stretching lineation.

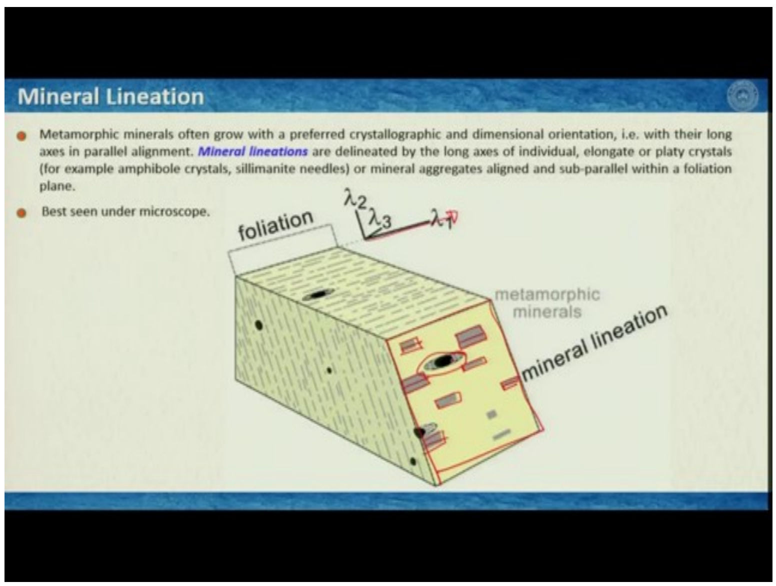
(Refer Slide Time: 37:35)



Here are some photographs of stretching lineations. So conglomerate beds, when they deform, you see the conglomerate clasts. You see the clast in the conglomerate here, they are stretched and defining a lineation on the surface. Here as well, some elongated grains defining the lineation here. Here as well. This is the fantastic stretching lineation.

These are old grains which got stretched during deformation. And even some voids in lime stones, these were initially circular. And they are now stretched to define a lineation, a stretching lineation in this direction. You can also use this image for measuring your strain using RFI method.

(Refer Slide Time: 38:46)

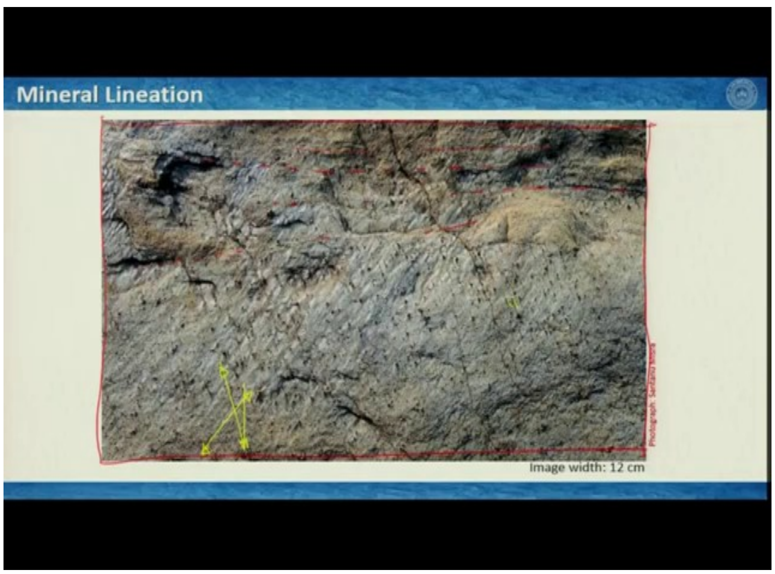


Now the mineral lineations, on the other hand are essentially minerals which formed during the metamorphism. So stretching lineation, the minerals or the lineation defining minerals are older grains. They are from the parent rocks. But in mineral lineations, the defining grains should form during the deformation. So they are metamorphic minerals and they often grow with a preferred crystallographic and dimensional orientation that is with their long axis in parallel alignment.

So, mineral lineation are delineated by long axis of individual, elongate or platy crystal, for example, amphibole crystal, sillimanite minerals and so on. Or mineral aggregates aligned and sub-parallel with the foliation plane. Generally we see them under microscopes. But sometimes we see in filed scale as well. I will show you a few photographs. But what we see here. If this is the foliation plane and again this is your stretching direction. This is the foliation plane.

So this metamorphic minerals, these minerals, these were formed the long axis are aligned along the stretching direction. And this one is a very special one. This is the pressure shadow. You will learn about it soon. So these are mineral lineations. The fundamental difference between stretching and mineral lineation, I believe you have understood it but I repeat it again. A mineral lineation is always defined by new metamorphic minerals and the stretching lineations are defined by minerals which were previously in the rock.

(Refer Slide Time: 40:47)



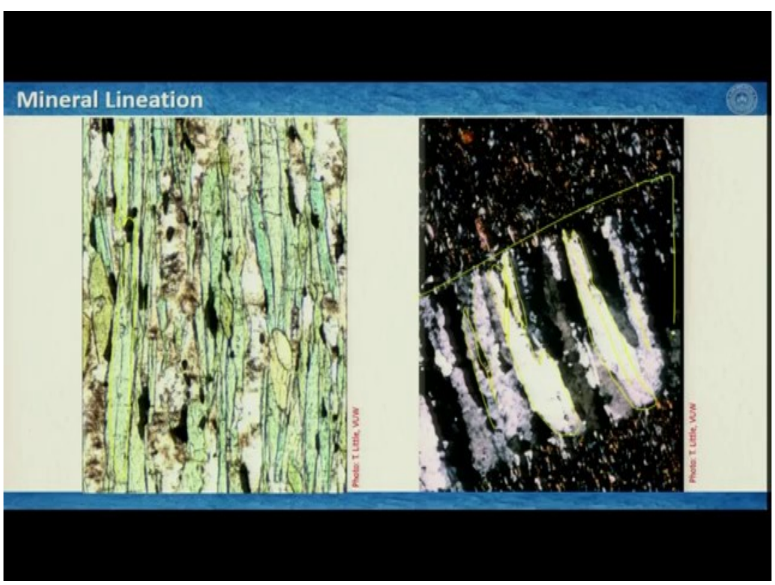
Okay, so here is an example of mineral lineation. The first of all what we see here that this is the trace of the bedding plane. If you have not figured it out, I just tell you. These are the trace of the bedding planes on this foliation plane. Now this foliation plane is characterized by crenulation lineation. You can figure out, they are like this. And very interestingly, mineral lineations you can see, these are oriented like this.

These yellow lines, so the minerals you can see, these are elongated, stretched and they are also defining a lineation. I wipe this one out. You have a look and figure it out, if my visualization was right or wrong. So you have crenulation lineation this way and you have mineral lineation this way. Have a concentrated look and figure it out, if you can see both.

(Refer Slide Time: 42:21)

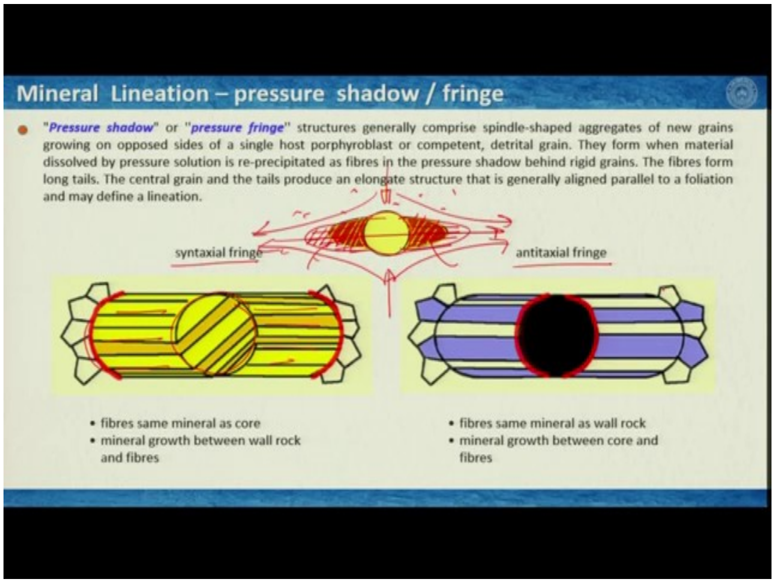
Now, mineral lineation can also can form in some areas, in inter boudinage spaces as you can see here. These are getting stretched. And you also can see it under microscope.

(Refer Slide Time: 42:35)



So, here you see this stretched new grain, here. These are your mineral lineations. And also, when we have vent filling then quartz grains are pretty elongated. They grow in the open veins in elongated manner. And these are also your mineral lineation, at least in this domain of visualization.

(Refer Slide Time: 43:14)

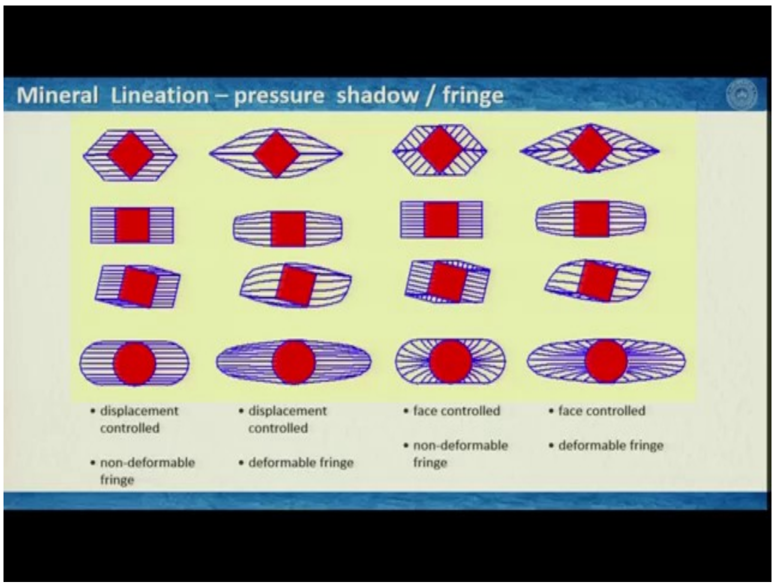


Now, we will see the mineral lineation in a different way as well. Not necessarily they are oriented or they grow along the directions. Sometimes what happens, if you have a pre existing clast, the clast is not deformed but because of the deformation the clast is rigid and around this clast two little caps on the two opposite sides due form. And these are known as pressure shadows. In other ways, if you have deformation in this manner, then everything flows this way.

If you remember the flow path of the (())(44:00) here, so clearly because this is rigid, you have a shadow zone here like this. Now this shadow zones are low pressure zones. So the fluid from all over the places can come and deposit here. And then later, these fluids can help to precipitate some crystal. And these crystals can be oriented along these pressure shadow directions. So, if we have multiple of this, then you define a lineation which is known as pressure shadow mineral lineation or fringes.

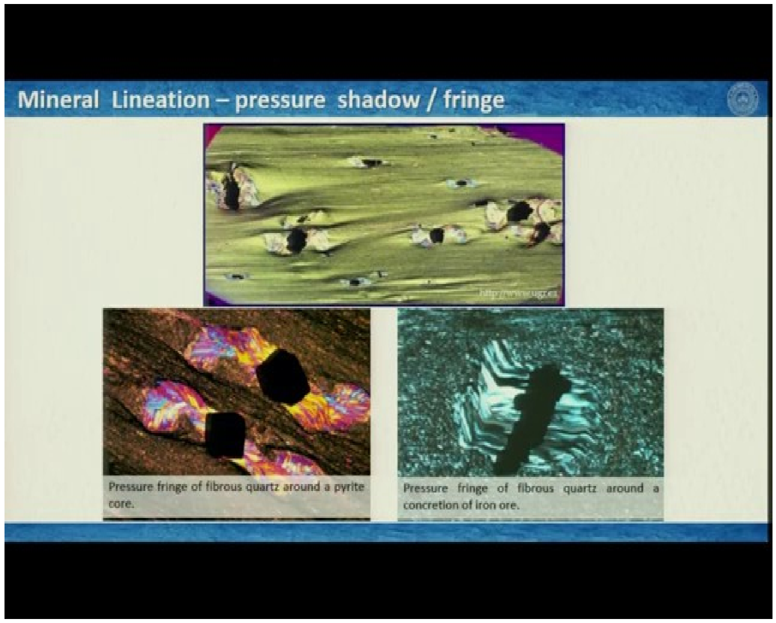
We will not go into the detail of the mechanisms of these. But there are two types of pressure shadow or fringes. One is syntaxial fringe and another is antitaxial fringe. In syntaxial fringe is, the fibers of fibers are generally same of the core. So, here is a core and the fibers. These are of the same composition. And then they also grow from the side of the wall rock. In antitaxial fringe, the composition of the fibers are different. And they, different from the core and they are actually similar of the wall rock. And this minerals this time in antitaxial fringe, they grow between the core and fiber.

(Refer Slide Time: 45:35)



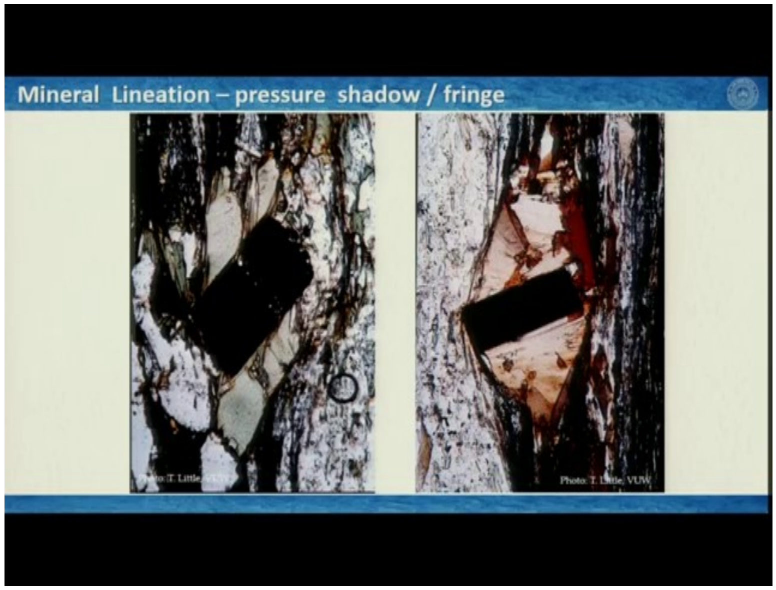
And there are many possibilities of looking at this pressure shadow and fringes. So it could be displacement controlled and it could be phase controlled. That means the orientation of the fringes can be governed by the overall strain features or the orientation of the fringes could be governed by the shape of the clast that we are talking about. So here is a table. If you are interested, you can look at all these things in the book of Passchier and Trouw, Microtectonics 2005.

(Refer Slide Time: 46:09)



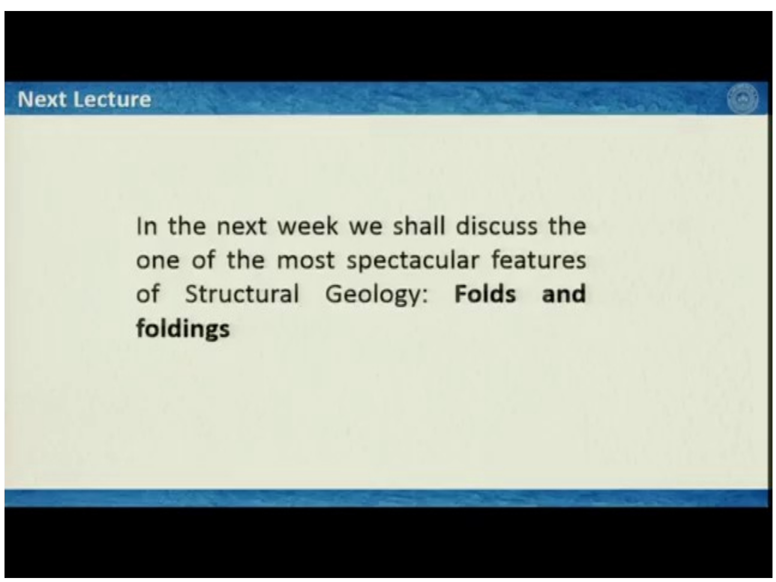
But here I give you some examples or images. You can see these are the clasts and these are the fringes or pressure shadows. So you can see that in the entire piece of this rock, these are defining a lineation. Here as well, you have some pyrites here as the clast, as a rigid clast and fine fringes are formed with quartz grains. Here as well, we have an iron oxide as the core and these fine quartz fibers are defining a kind of lineation in the area of observation.

(Refer Slide Time: 46:59)



You can also have different types of things. Not necessarily you develop some fibers. So here this is a core. And you see some large crystals are deposited here. In this case as well, you have a large crystal which is your clast and you see in the pressure shadow you have some phyllosilicates deposited.

(Refer Slide Time: 47:25)



So, with this note, I finish this lecture, and this week’s lecture. So we learnt foliation in two lectures and lineation in one lecture. I gave you a very basic idea of these two topics. But we will continue with these two, when we will learn fold and foldings, which is the topic of our next week's lecture. And then also we will use the foliation and lineation extensively when we will study ductile shear zone. Thank you very much. I will see you in the next week.