**Geomorphic Processes: Landforms and Landscapes**
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**Lecture – 30**
**Glacial Landforms (Part III)**

Welcome back. So in the previous lecture we discussed about the different type of glaciers, either it is continental glaciers or Alpine glacier. And we very briefly discussed about the Firn line or we can say the zone of ablation and zone of accumulation.

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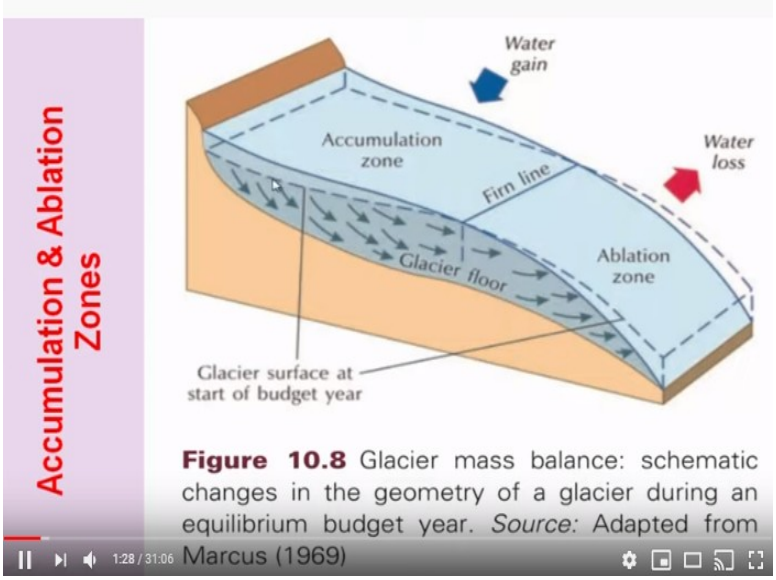


So we are coming back to this one again. So what we have is the glacier mass balance and this will keep changing over the period. So you have the zone of accumulation where you gain the snow or the ice accumulation will be there. And below this line there will be an ablation and this is where you keep losing the snow during hotter phases. So glacial mass balance this is schematic changes in the geometry of a glacier during an equilibrium budget year.

So this is what has been shown here is glacier surface at the start is this and over the time an all the time it gets here and this is the zone of. So if you increase the mass this side, you reduce the master side. So this is what has been shown here.

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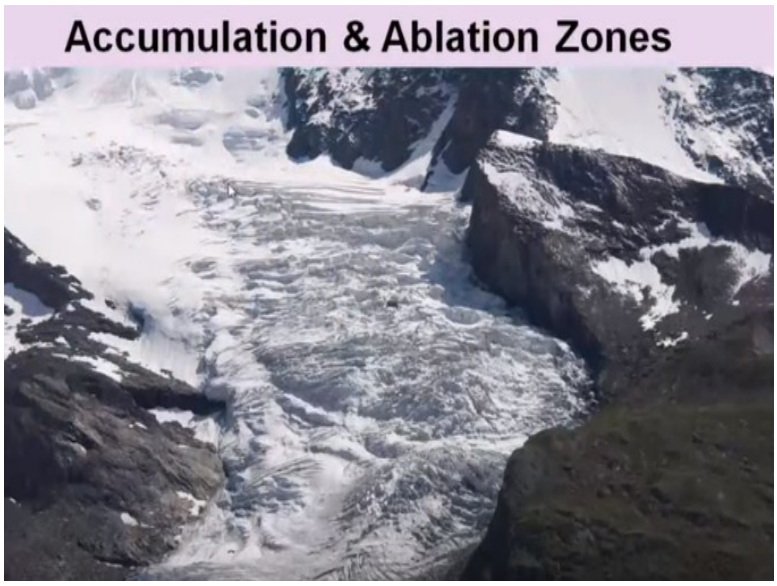


And if you see this photograph which shows the the accumulation zone here and this part or this line is the line of the Firn line. So below this you will have the loss whatever the last you will take place in terms of the losing the ice here. So the glaciers so melting of glaciers will take place in this and whereas mostly this area will remain stable. So this marks the this is the close up of that this mark the line of the Firn line. And this is an ablation zone and this is an accumulation zone.

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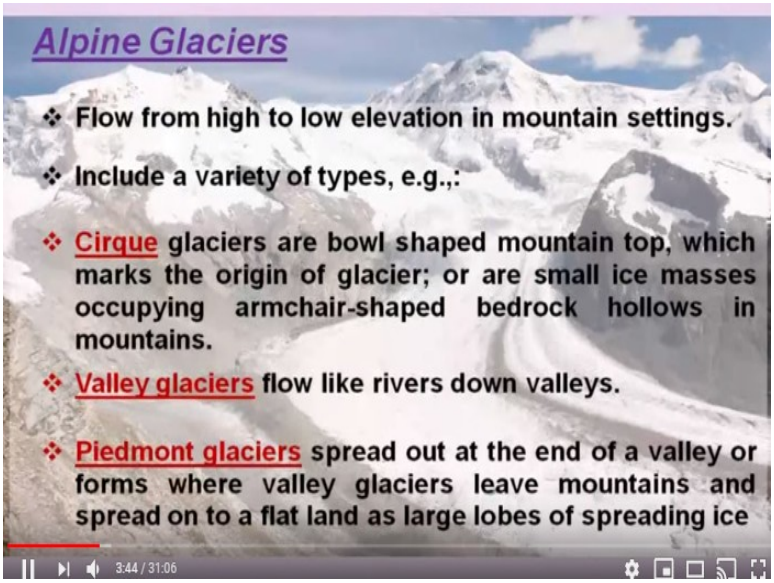


Now Alpine glaciers mainly flow from hill to lower elevation in mountain settings include a variety of type. For example, these are the most commonly seen features are the landscape cirques and this landforms or the glaciers which shows bowl shaped mountain top, which marks

the origin of glacier. All are small ice masses occupying armchair shaped bedrock. Then we have valley glacier flows like rivers down the Valley.

Then we have Piedmont glaciers spread at the end of the valley or forms with valley glaciers leaves mountain. So very much similar to the what we were talking in Fluor landscape level alluvial fans. So when they are confined within the valley and then became unconfined. So spread out of the glaciers when they leave the valley or mountains and spread out on the flatland as a large lobe. So these are turned out as Piedmont glaciers.

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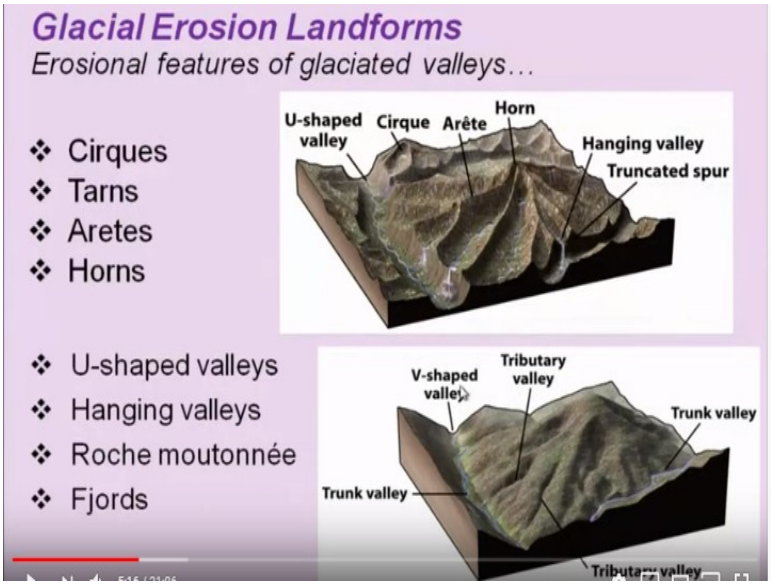


So glacial erosional landforms for glaciated valleys mostly you will come across Cirques, Tarns, Aretes , Horns and then along with that you will also come across U shaped valleys, hanging valleys, Roche moutonnee or V shaped and Fjords. So one by one we will try to see the features which are been the erosional features of mainly related to the glaciated valleys one by one, how it looks like today and please remember that this landforms which had been listed here.

The U shaped valleys, Cirques, Tarns, Aretes, Horns hanging valleys, truncated spurs or truncated valleys and V shaped valleys. These are all features you will see in or you will be able to identify in Alpine glaciers only.

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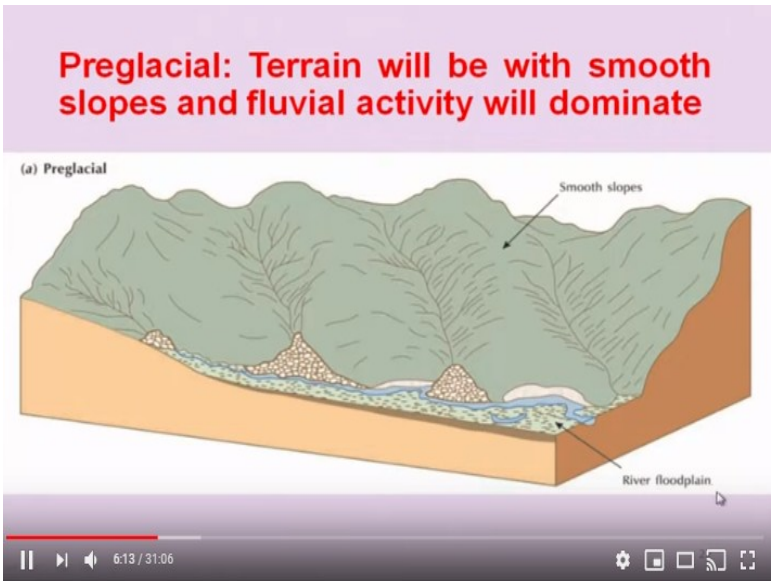


So pre glacial terrain will be with smooch, slopes and fluvial activity will dominate. So this is pre glacier, before the glacial landscape or glacier occupied this area. So smooth topography or the smooth slopes and most of area is covered by the surface, not an erosional surfaces. And the deposition and the drainages are very much similar to what we were looking in the floodplain area. So we will flood Plains will exist and all that. So overall topography will be with smooth slopes.

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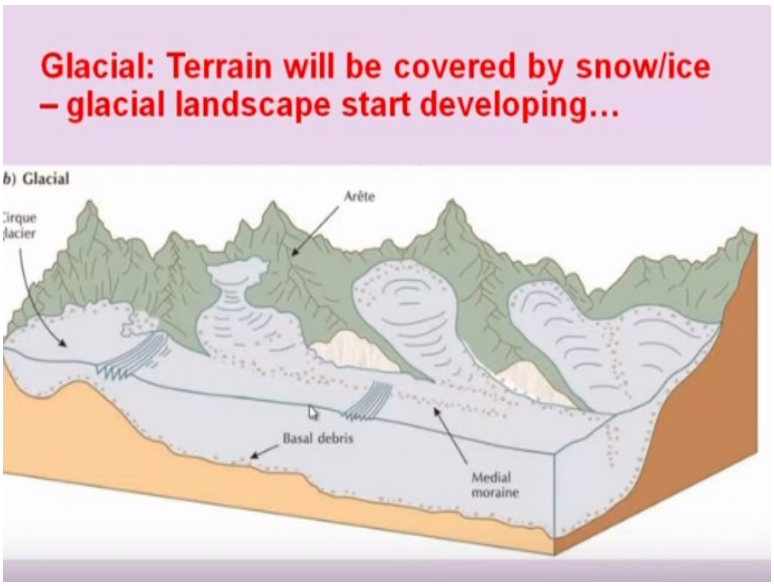


Now coming to the glacial time, the terrain will be covered by snow glacial landscape start developing. So the pre glacial smooth terrain, but now we are getting slightly sharper ridges and the movement of the ice mass or the snow will result in the formation of different landforms. So

for example Cirques then when there is right now what we see is the completely full of this snow the whole area which has been shown here and this part is completely covered including the valleys here or the space between the two mountains.

Low lying areas are all covered by snow even the floodplain region which has been seen here is covered by the snow. So you have thick pile of snow and as we learn about the, the supra glacial, sub glacial and N glacial features or the movement of the it will take place of movement of, of mainly the snow will take place in this region and then we will see the postural landforms which had been created termed as moraine. So this at the time of glacial.

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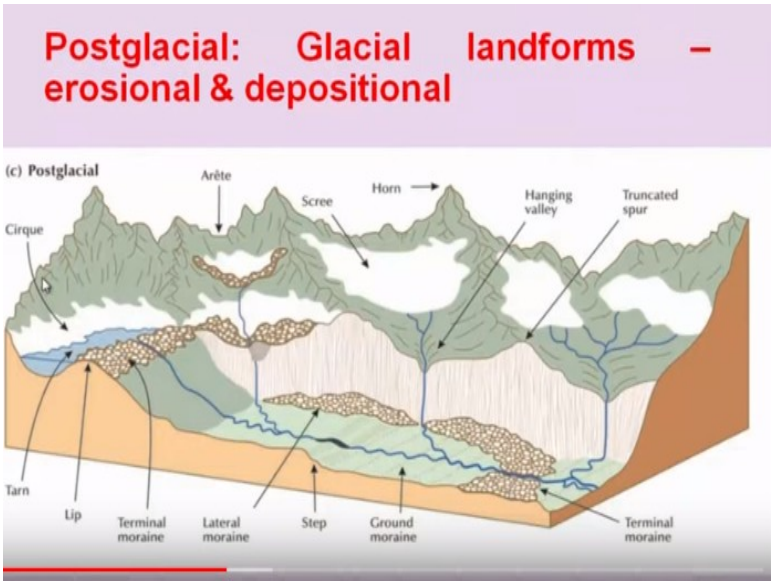


And then post glacial so now there is a retreat of glacial and the system which were freezed will start getting extended. So again, you have drainage and then at the same time you have the moraine comprised of the sediments loose sediments are moved along glacial movement as well as deposited. So you have terminal moraines so terminal moraines as seen here also as well as the medial or the lateral moraines.

Then you have Arete, Cirques, Horns, Hanging valleys because the glacial mass, which was been covered over here eroded and resulted into the formation of such sharp cliffs, truncated spurs and all that. So we will see a few of these examples so post glacial what you will find is both erosional and depositional landforms.

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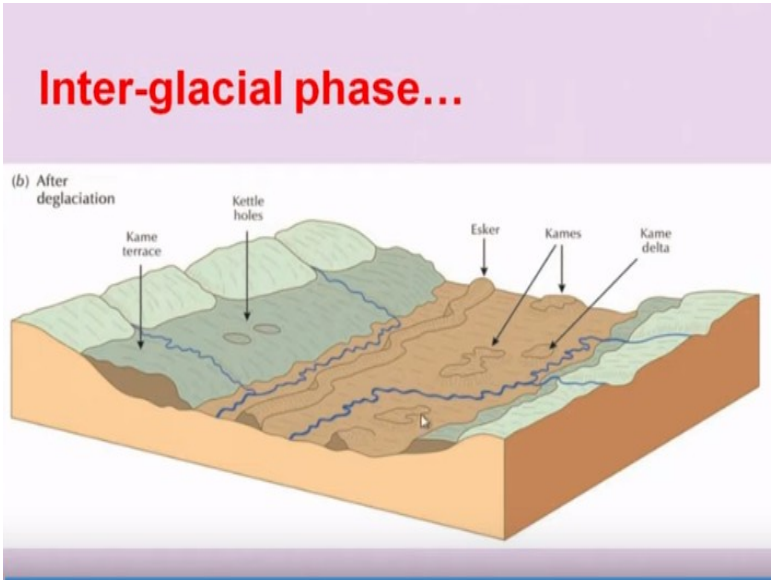


So transition phase of glacial you will again have the formation of the drainages. The braided stream will come into existence and also you will see some fluvial activities in the region. Also at the same time in the inter-glacial phase. So previous one was your transition phase and this is at the time of the inter-glacial stage.

What you will see the formation of Eskers, Kames, Kettle kame terraces slightly elevated surfaces as compared to this region are termed as kame terraces or kame islands here or do you see here is the almost like plateau like features kames and this is after the glaciation. So during inter-glaciation they will develop drainages and the Eskers are formed and because of the erosions and left out areas are flat hetero type regions are kames, then kame delta or maybe you can say kame terraces and the kettle holes.

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This is the photograph showing several features here. One is Cirque glaciers fill mountain top bowls or small ice masses occupying arm chaired shaped bedrock in mountains, also termed as Corrie amphi theatre like valley created by glacial erosion. So you have this is again an armchair shape so they are separated by this area is we can say is bordered by two Aretes on the either side. Or you can say it is in mountain filled with snow and it is bowl shaped and they are also termed as corrie in some countries. So this is the part of your Cirques.

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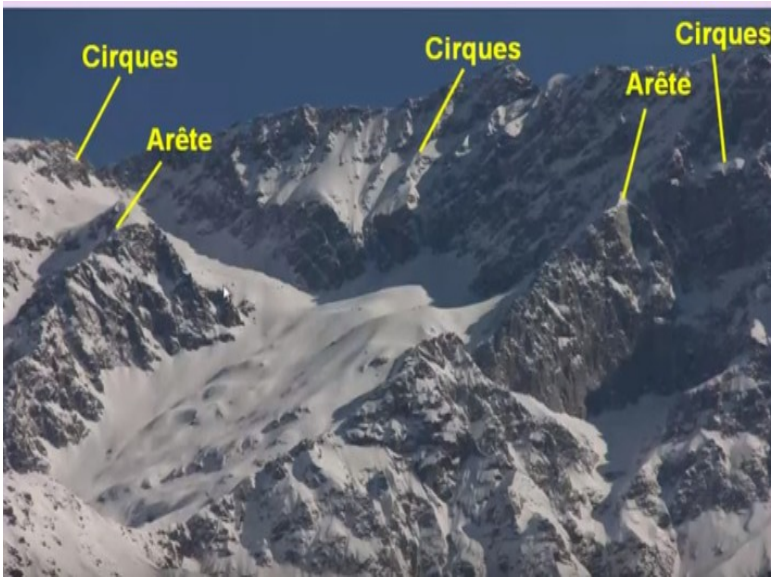


Similarly or here if you see the closer up there is a portion of cirques and these are two Arete so you have cirques, you have cirques again, another one here and this ridge is your Arete. So you

have smaller Cirques here larger one here separated by two Aretes here. So it is an armchair similar to armchair.

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This is another photograph of cirques here also again you can easily mark the Firn line, ablation zone and here accumulation zone.

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Piedmont glaciers spread out at the end of the valley or form where valley glacial leaves mountains and spread on a flat or large lobes. Similar to what we were learning in fluvial landscape.

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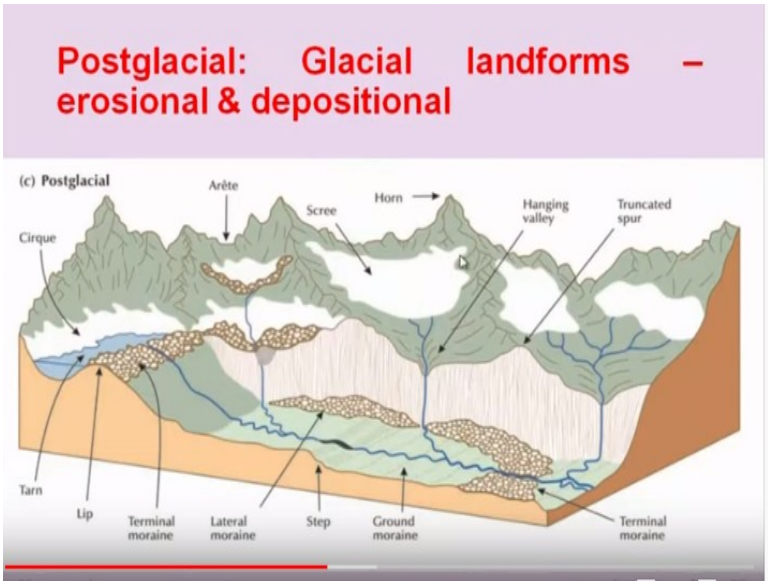


Then Post glacial landforms further if we see the examples of horn and all that let us see in the next slide.

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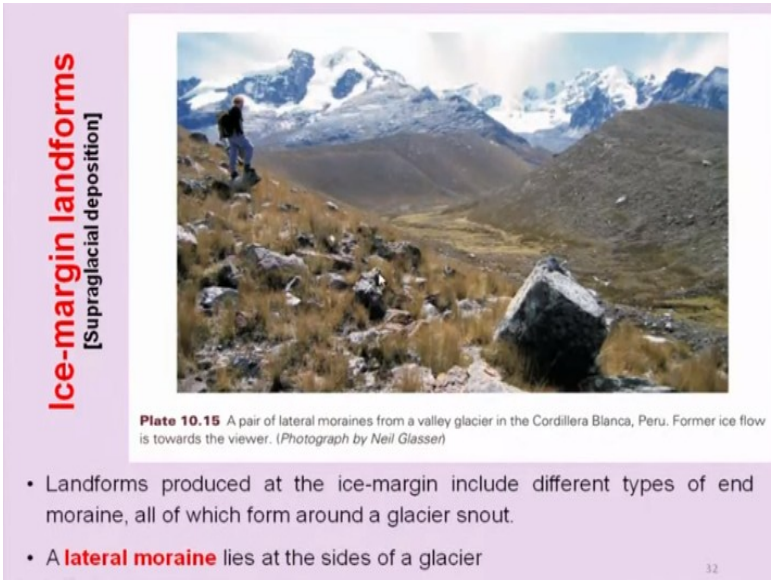


So this is another depositional part here is your lateral Moraine. So landform produced at the ice margin in include different type of end moraine, all of which formed around the glacial snout. A lateral Moraine lies at the sides of glacier. So usually the whole area covered by snow when snow moves or the glacial moves, it will erode and carry the material or the sediments. Now this sediments are deposited during the inter-glacial period in transported behind the glacial movements and deposited finally to a inter glacial. So the deposits which are been left out on the either side of the glacier are termed as lateral moraine.

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So if you see these are all lateral moraines.

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So again this slide this is an example of side moraine but this is side moraine for this one, this forms a medial moraine because 2 valleys are meeting here. So merging Valley glaciers within medial moraine.

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Again an example of the lateral Moraine another example of lateral Moraine. As well as you can see here, the Arete small one Arete here and then large area, which is we can say the bowl shape or amphi theatre like feature Cirque. So you have Arete here so you would find Arete is knife edge ridge so very sharp ridge formed by 2 Cirques that have eroded towards one another.

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Similarly over here this is a Cirque here this is an arm shaped feature cirques and Firn line, zone of ablation, zone of accumulation.

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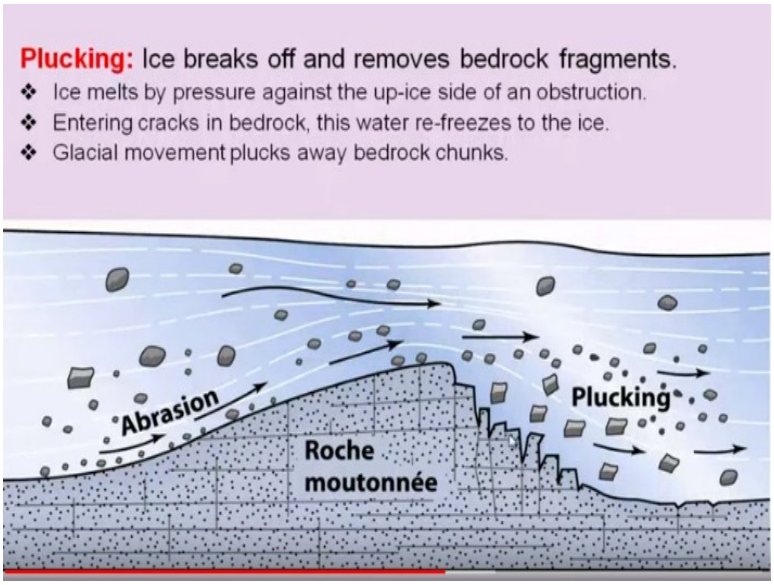


Now plucking is another common phenomenon, the process which is experienced in the glacial terrain and this is nothing but ice breaks off and remove bedrock fragments. So what do you have as the movement of the snow will erode and carry the sediments within it? And in some location, because of the fracture rock which are available, the snow or the ice will get filled up in the cracks will get rephrased again. And during the movement it will start plucking up the rock fragments.

So plucking ice breaks off and remove bedrock fragments. So this is the breaking process as well as removing the rock fragments. Ice melts by pressure against the up-ice side of an obstacle. So ice melts by pressure against the up-ice. This is the up-ice side of an obstruction. Entering cracks so ice will enter the crack and refreezing will help in breaking the bedrock. So glacial movement plucks away bedrock chunks so it will erode in form of such chunks.

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Now coming to another feature again, an erosional one which is formed by 3 or more Corrie Cirques. So we have one cirques and other Cirque here and third the backside on this one. So if you combine 3 Cirques then you have a feature on a mountain peak known as Horn. And this photograph is from Switzerland which shows with this from the glaciated region, which shows the formation of Horn.

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Now coming to the proglacial features we have kettle. So kettle hole or pond bowl shaped depression. So bowl shaped depression in glacial sediments left when it detached or buried block ice melts often contain a pond at the base of the mountain. So this is the example of kettle formed a deep base of the Hill. If pond is formed close to cirques, then it is termed as Tarns.

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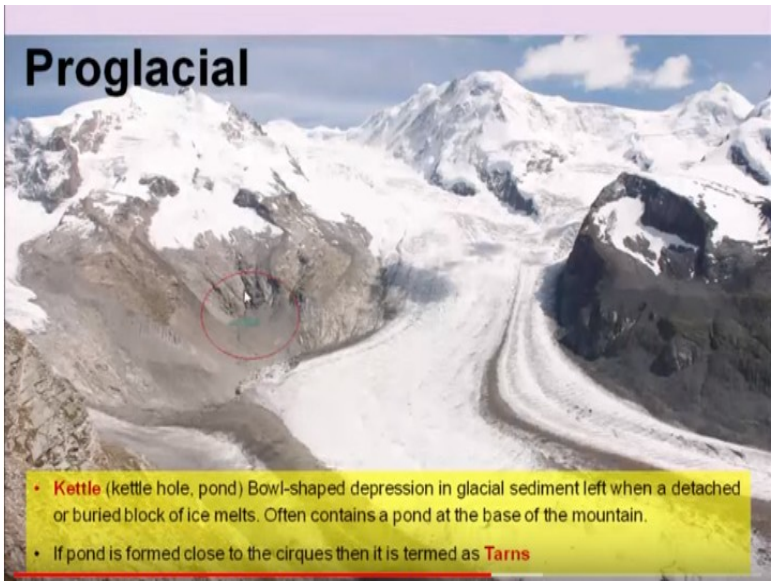


So this is what you see here this is the cirques and this one is the kettle. But since it is close to the cirques, it is termed as Tarns.

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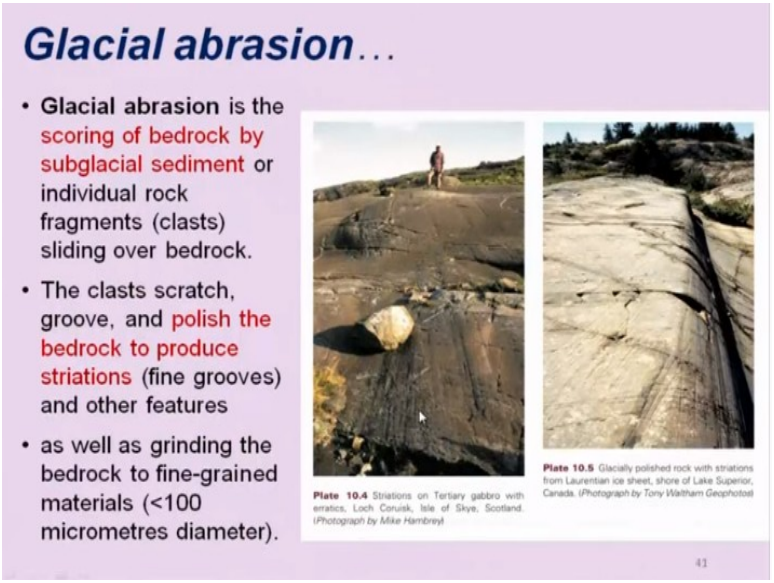


So Glacial abrasion basically what we see is when the coarser particles or the fragments which are moved at the basal part or along the basal part of the glacial, then such striations are developed because of the polishing or scratching of the surfaces. So the material which has been carried, the fragments sliding over the bedrock, and these are all what we call subglacial sediments.

So they will scratch groove and polish the bedrock to produce striations or fine grooves. As well as grinding the bedrock to fine grade material, which can be measured like up to less than 100 micrometre in diameter. So this process will happen whenever there is a movement. So this is what we term as an glacial abrasion. These are the features or striations, which when left out and such striations will give us an clue that there was once in a past there was a glacial which moved on this terrain.

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Now coming to another important features is a typical U shaped valleys, which had been shown here. So glaciers, snow will occupy or must have occupied in the past this whole area from this to this, but now after the retreat of glacier or ablation or maybe you can say the melting of the glaciers, the movement of snow as resulted into the formation of U shaped valleys.

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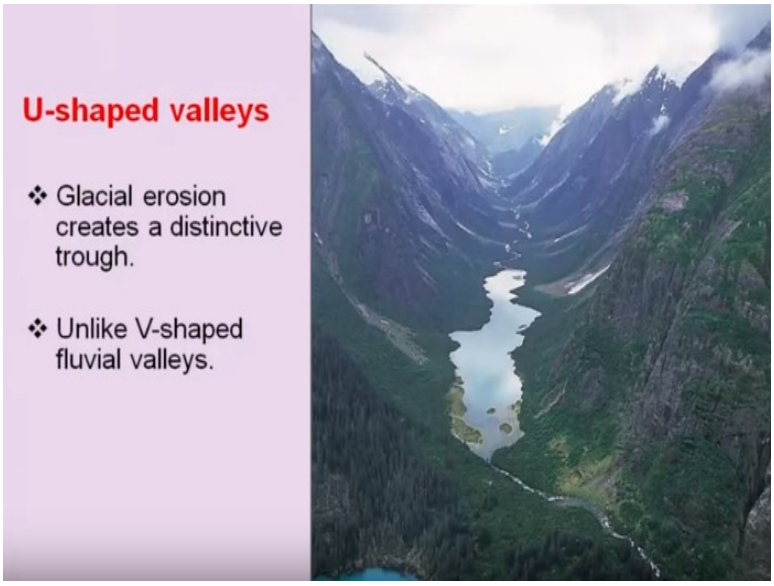


So we can say that erosion due to glacial movements will create a distinct trough. So distinct trough will be created by the Glacial movement. Unlike V-shaped fluvial are narrow, but this are wider and U in shape. The difference is very clear between the U shape and the V shape valleys. V shape valleys are narrow, gorgeous and U shape valleys are basically broad and rounded one.

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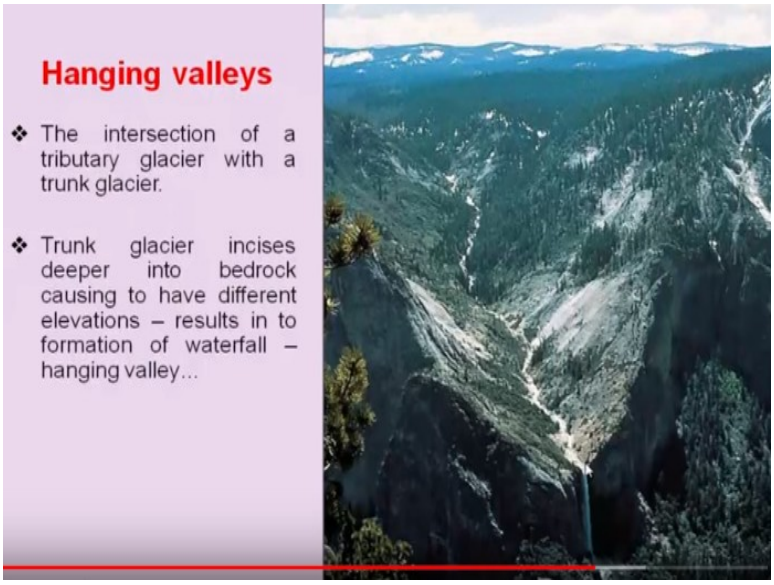


Again, hanging valley as we were talking about that if glacial mass, which used to cover this area retreat, then it will allow the river to flow from this point had and higher elevated hanging valleys are formed. So the intersection of the tributary glacier within trunk glaciers. So these tributary glaciers and the trunk glacier must be sitting somewhere here down. Trunk glaciers

incise deeper into the bedrocks or trunk glacier incises deeper into the bedrock causing to have different elevation formed into formation of waterfalls.

So this is what is been seen here. They have hanging valley and then waterfall which has developed and the hanging with the side.

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So this is what we see in case of the sub glacial deposition mainly the drumlin and they will occur in group. So it is an elongated hill with an oval or egg-shaped. So this was between stoss side and this will be leever side. So all you can say it is cigar shaped out line will be so that you will see such multiple ridges which exist.

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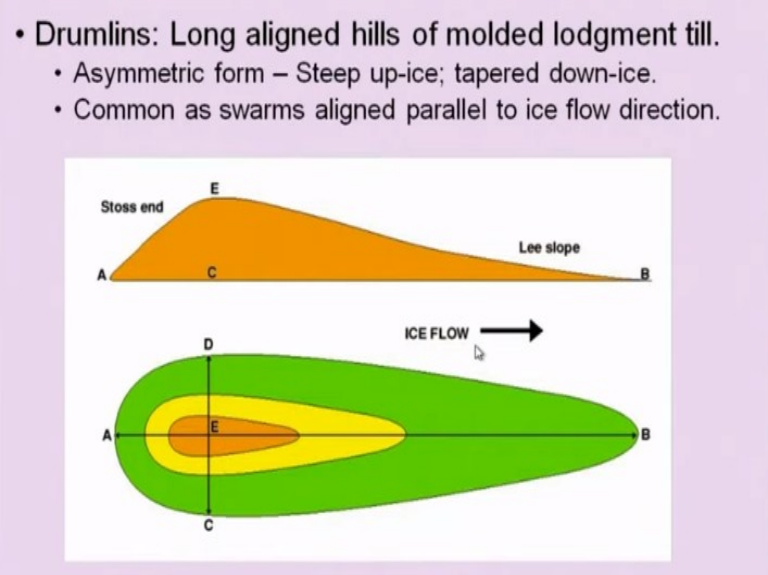


So drumline long aligned hills of molded lodgment. This is what is been shown here. So cross-section if you see he will have this stoss side and leever side and this will be the there is a flow direction. So usually the egg shaped, this will be seen as the egg shaped or cigar shaped. So the pointed side can be the ice flow direction.

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So typical shape of drumlin this is the flow direction and you will see multiple such ridges. So this is again a deposition feature.

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**Plate 10.16** Nepal Himalaya, Langtang Himal, Kyimoshung Tsang glacier, showing ice retreat over last 400 years, leaving bare stony ground inside terminal moraine left in Little Ice Age. (*Photograph by Tony Waltham Geophotos*)

This shows the signature of retreat of glaciers. So this portion over here at the base, this is from Nepal Himalaya matures the ice retreat or glacial retreat over last 400 years leaving bare stony ground inside the terminal moraine.

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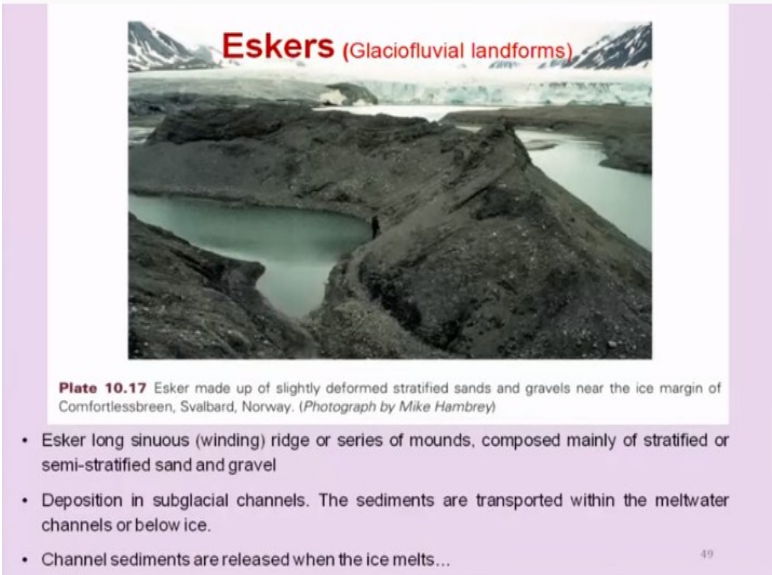


Coming to another feature Eskers these are Glacio fluvial landforms. So Eskers are long sinuous winding ridges. So these are the typical deposits which are termed as a long sinuous ridges termed as Eskers and they will also occur in series of mounds, composed mainly of stratified or semi-stratified sand and gravel. Deposition in subglacial channels, the sediments are transported within the meltwater channels or below ice. Channel sediments are released when the ice melts.

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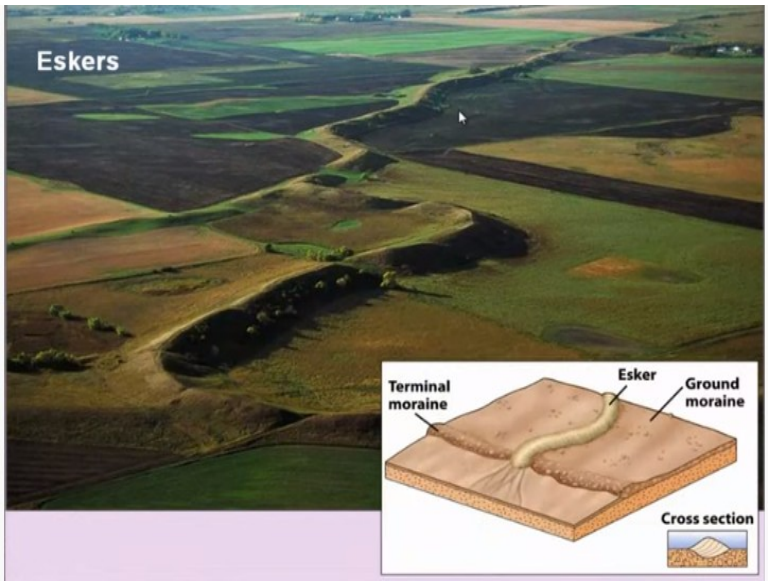


And finally when the landscape is completely devoid of Glacial covers, such sinuous ridges can be easily seen spread over the terrain these are termed as Eskers.

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Well, this is an U shaped glacial trough area flooded by sea or ocean waters and termed as Fjords. And Fjord floors usually lies below sea level and is a glaciated valley drowned by ocean water.

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I am coming to again the erratics Kangra Valley is in India. So this flat terrain what you see is the surface or the area which used to be covered by glacial during past geological period.

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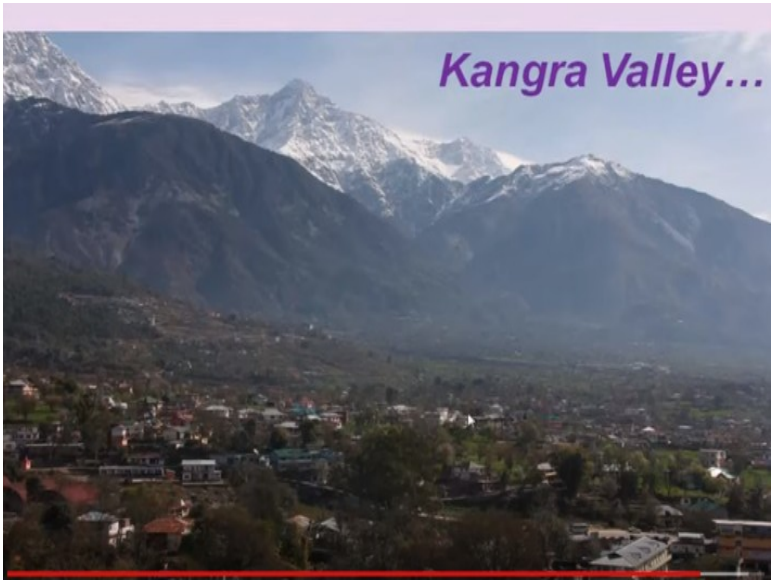


This is how it looks like, but right now what we see the glaciers are sitting and they are mountains.

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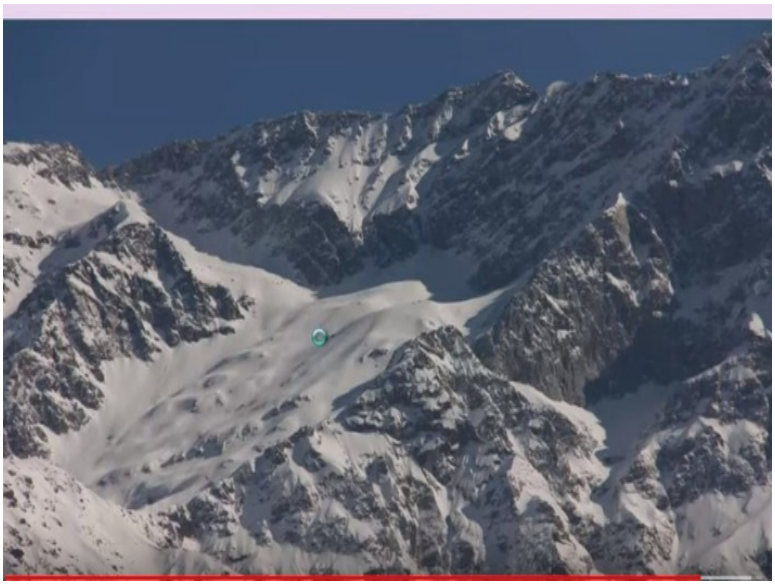

If you move to this terrain what do you find? So this is in the higher portion, whichever showing at the back here. So you have this portion so we have we still see the glacier.

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But if you move down into the valley then you have a flat surface. The typical glacial terrain, and then those surfaces are been incised by the present or recent fluvial system.

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Huge boulders the surfaces are composed of huge boulders, which are mainly the part of the glacial sediments, which were moved or the moraines.

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The glacial deposits look something like this what do you have, this is shown in the succession.

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And then huge boulders which were been transported at the time of the glacial movement.

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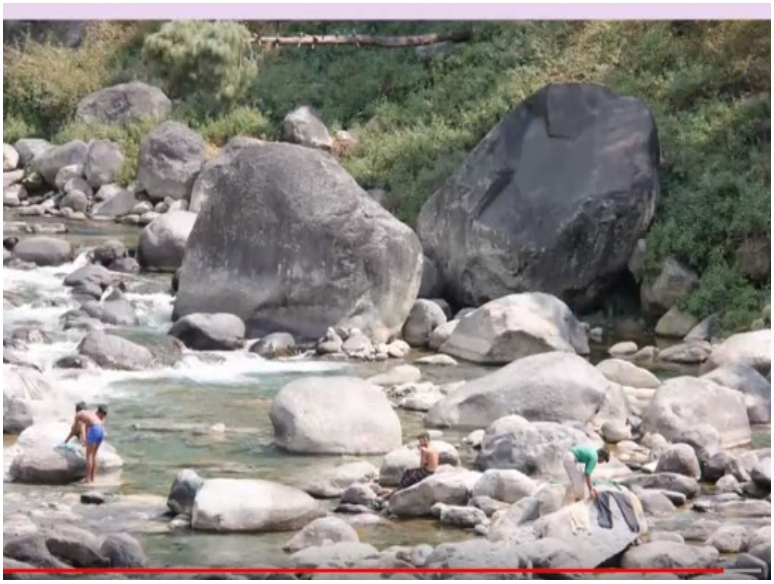

Even in the present days channels you see in huge boulders when this surfaces were been eroded.

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And is the one which I was talking about the erratic a large isolated angular block of rock carried by glacier and deposited far from its source. So such an huge boulder that is definitely were not carried by the streams, but of course by the glacial. So you can look at the size of the erratic huge angular to sub angular boulder.

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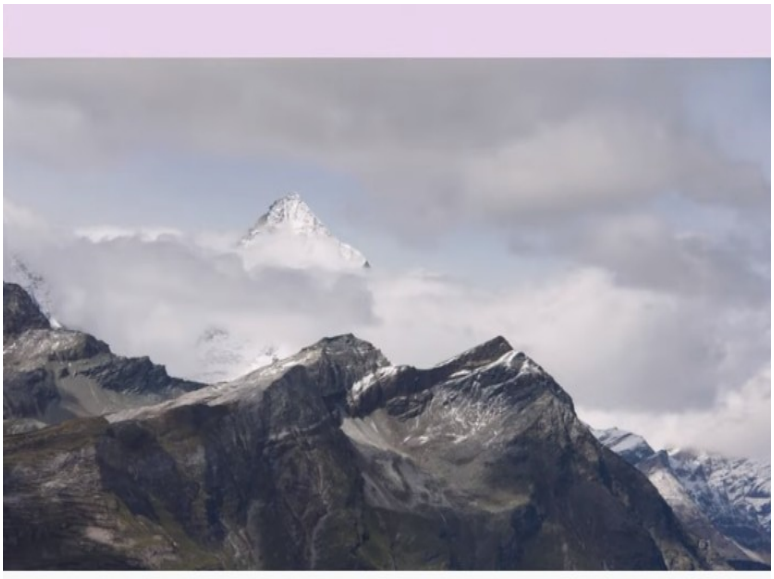

So with this I end this part and we will continue with new topic in the next lecture. Thank you so much.