Geomorphic Processes: Landforms and Landscapes
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Lecture – 21
Fluvial Processes and Related Landforms (Part VII)

Welcome back. So, in previous lecture we discussed about the different stages and the associated land forms. One can see in different areas that is youth mature and cold. Now if you come down to this figure which shows that in the uplands but you see is the narrow valleys.

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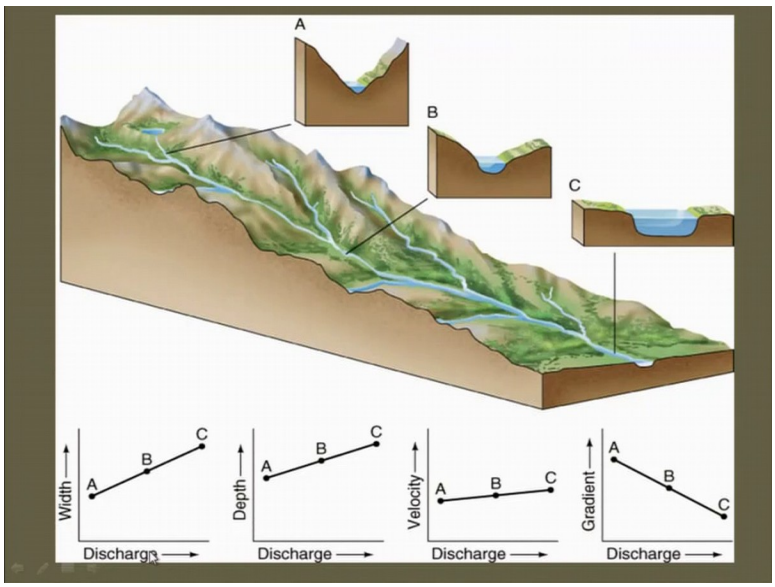

Where it is in the, the central part, you find as you move towards the mouth, you have broader were these comparatively and then much broader valley at the end and also this shows the width and the discharge with respect to the different locations that is A, B and C. So, you have the velocity, once as one is width, discharge relationship between depth discharge valley discharge and gradient discharge.

So, basically what it see as shows us the day gradient decreases. As you move towards the mouth on the discharge is comparatively sorry they did velocity comparatively increases as the discharge increases, whereas, the depth also increases along with the discharge and the width also increases along with the increase in discharge. So, change

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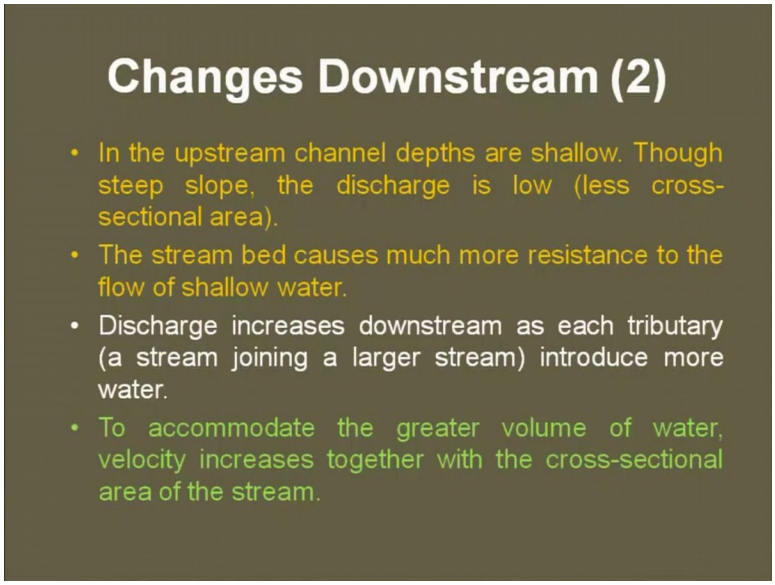

Changes downstream if you look at so in the upstream channel depths are shallow. Though steep slope, the discharge is low, less cross sectional area. So, what we will looking at the V shape valleys the stream bed causes much more resistance to the flow of shallow water discharge increases downstream as each tributaries, that is a stream smaller stream joining the larger streams introduce more waters and of course.

Along with that, he will have the bed load also. To accommodate the greater volume of water velocity increases together with the cross sectional area of the stream. This is what you see in the downstream. So, the channel pattern varies from upstream to downstream. And we also discussed about the different land forms starting from V shape valleys, narrow gorgeous up to the broad valleys in the delta like planes.

And that what we are talking about the old stage close to the mouth in the medial part he have mature state and in the upstream area, we have the youth state. Now, channel pattern

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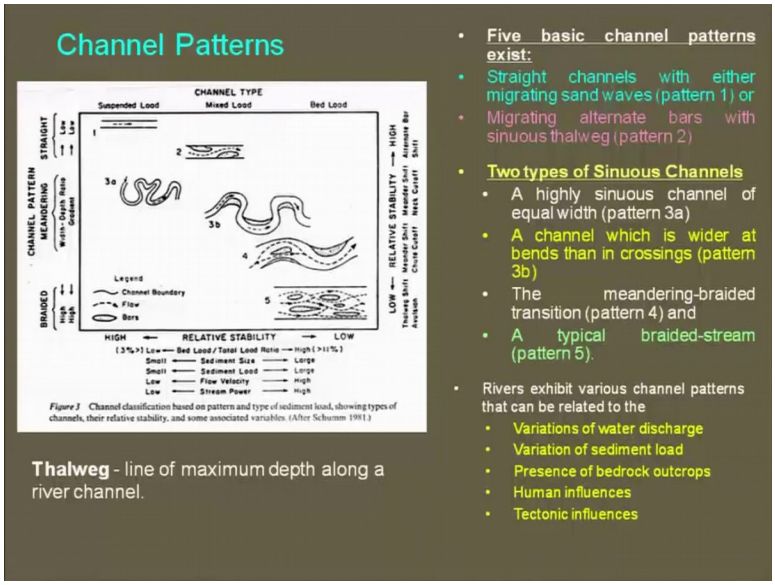

Further if you take into consideration this has been classified based on the sentiment load which has been shown here. So you have suspended, mixed and better So, Shannon classification based on pattern type of sediment load showing type of channels the relative stability and some associated variables, this is after show, which talks about that how the pattern will change with respect to the bed load and all that.

So, five basic channel pattern exist this we will also talk when we are talking about tectonic to morphology. So, they are also this channel patterns plays an important role, but in general what we see is the five basic channel patterns channel straight channel with either migrating bars at in one at in two this migrating alternate bars again, this is the straight channel, but it is in the form of the mixed bed load.

So, two typical sinus channels three a and 3 b where you have a highly sinus channel pattern three a with equal width throughout the designers channel. So, you have equal width of the channel were is three b the channel width various. So, a channel width a wider at depends, so, it becomes wider it depends this is the channel three b and then you have 4a which is meander braided transition.

So, this is the four and then that this what you enter into the bed load and typical braided channel. So, you have total bed load in this pattern. So, you have typically the braided streams. So, river exhibits various channel patterns that can be related to variation in water discharge. Variation in sediment load, presence of bedrock, outcrop human influence, tectonic influence.

So, these are all important aspects which can play an important role in changing the channel pattern from straight to braid it. So, this is what has been showed here that the straight channel are highly stable whereas, the braided channel which have the bed load are the stability is very low. So, this you keep in mind that the channel pattern varies from straight to braided.

And they are influenced one is variation of discharge or water discharge variation and sediment load. If the sediment load increases, the channel pattern changes presence of bedrock human influence and tectonic influence. Now, along with this another important aspect which will affect the change in channel pattern is the slope. So, one is the gentle slope and another you have the steeper slope.

So, changing the slope will also affect the channel pattern. And as the change in the channel slow eventually will result into the change in the discharged that the velocity also and velocity will affect the road ability and the road ability will result into the reporting of more sediments. So, sediment bed load will change, hence the pattern will change. So, this is all interconnected. So, this is important,

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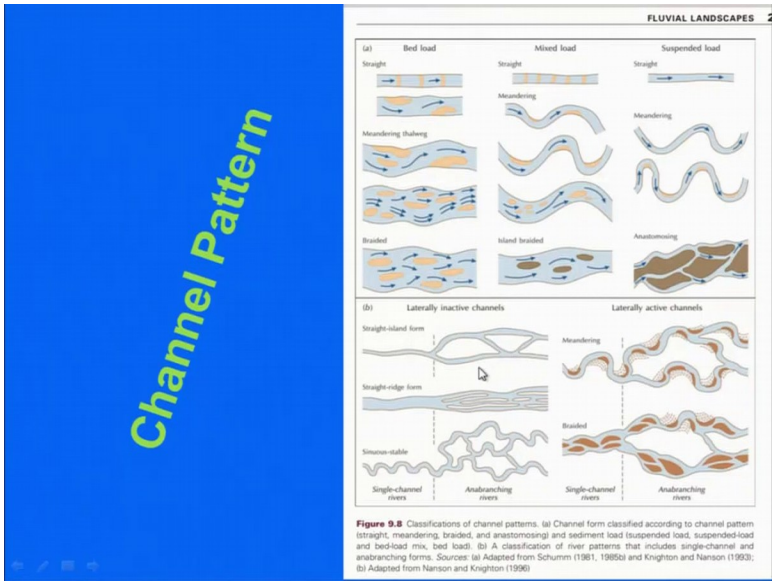

Which you can remember and this figure also talks about the similar type of the channel patterns, this is also after shumm. So, you have from suspended bed load or suspended load to the bed load. So, you have from straight to the meander and then bed load you have the

channel which is straight bars where is here from anastomosing to braid it. And this channel pattern we will discuss later but basically, if there is a change in the slope.

Then the channel patterns will change from sinus to anastomosing or you have single braided channel to Ana branching channel or voting see here, so, multiple meandering channel from entering channel and single straight channel to island chain channels. So, these are the few examples. Which also you will come across.

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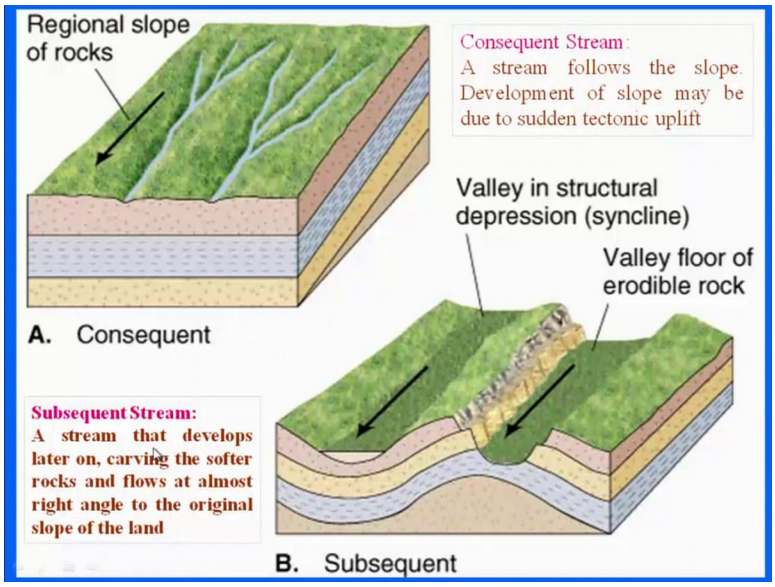

Now, coming to the very basic thing that different type of streams what we usually we come across and this is based on the surfer for geology and the slope which we can classify one is the cons const stream. So, consequent stream a stream flows of follows the slope basically, or flows over the slope sloping surface. So, they are been termed as the consequence stream. And such slopes could be natural or tectonic slopes are formed because of the ongoing the formation.

So, this the stream follows the slope developed on development of or steam follows the slope the development of slope could be because of the sudden uplift then comes to the subsequent stream subsequent streams that develops later on carving the softer rocks and flows at almost right angle to the original slope of the land. Now, when we say almost fight angle, then they are flowing over the folded terrain.

So, the folded beds if you have a which are eroded, the soft rocks are eroded away. So, either they follow the synclinal area or the road the crust part of the fold, then you can say that these

are all subsequent stream, they are not exactly following this slope, but they are against this slope. Then we have

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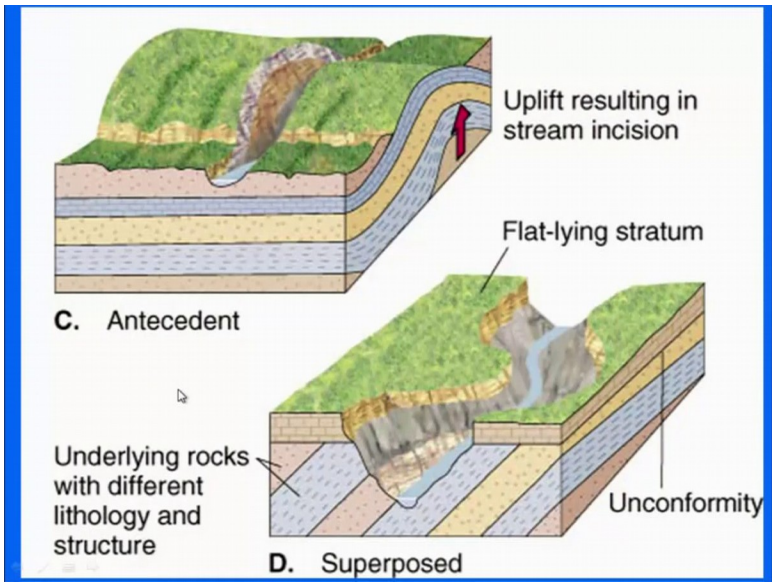

The antecedent stream are mostly those streams, which cut across the folded belts. So, most of the stream which are crossing Himalayas are antecedent stream, because the folded mountain chain the inside the folded mountain chain and flow across them they are termed as antecedent stream. Then come the super poor streams, where what you see is that they are they flows across the different methodology and structure.

So, what we see here is the unconformity a between the inclined beds here and the horizontal bird here. So, they are flowing on across the different lithology and structure. So, these are been termed as superposed streams. Now,

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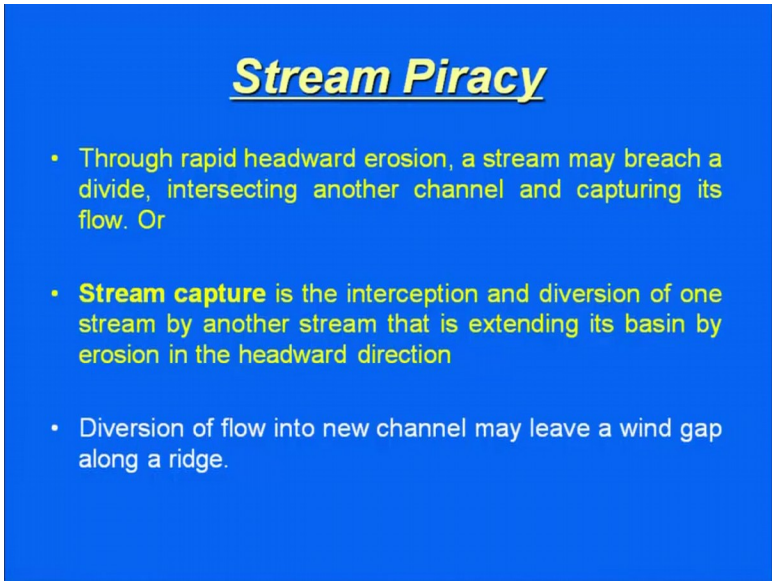

Stream privacy is nothing but the capturing of the river system or the basin. So, it can happen to headwear erosion because the most of they are mostly the drainage is are the extension of the drainage basin is because of the headward erosion. So, through rapid headward erosion a stream a breach at divide intersecting another channel and capturing its flow or stream capture is the interception and diversion of one stream by another stream.

That is extending its basin by erosion and the headward direction. So, the diversion of flow into new channel may leave a wind gap along the ridge. This is very common, where the erosion is intense. So, stream piracy if you look at

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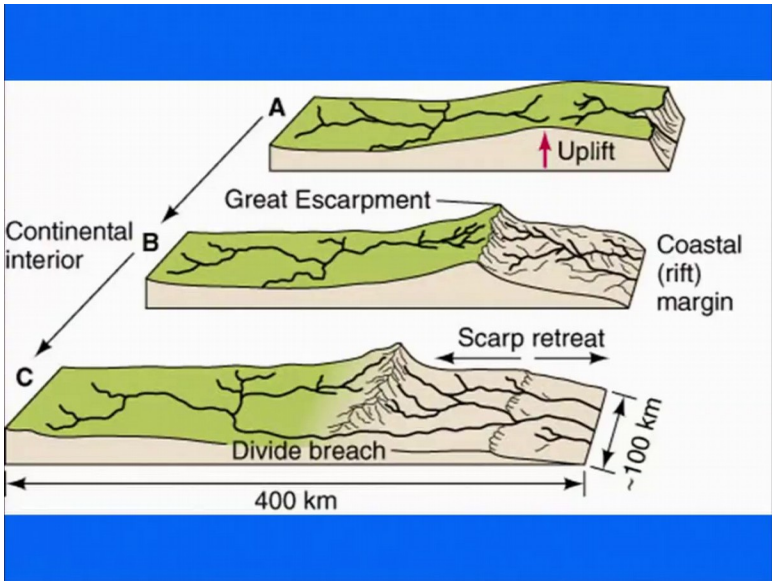

In this sketch, it has been shown that for example, you have an uplift which is going on here. So, you have a drainage divide where the drainage are flowing in a positive direction, but

slowly because of the extensive erosion, both the drainages drainage are evolving and moving towards the headward side. So, this drainage is moving towards headward here had this as moving to your land finally, at one point of time because of they divide breach.

This capturing can take place and whole system all the drainage basin, which was pouring the water towards this basin will finally contribute to this river basin. So, this is an example which is because of the drainage breach divide bridge and deliver capturing phenomena can take place and result into the extension of the drainage basin. This has also been termed as stream piracy. Drainage pattern.

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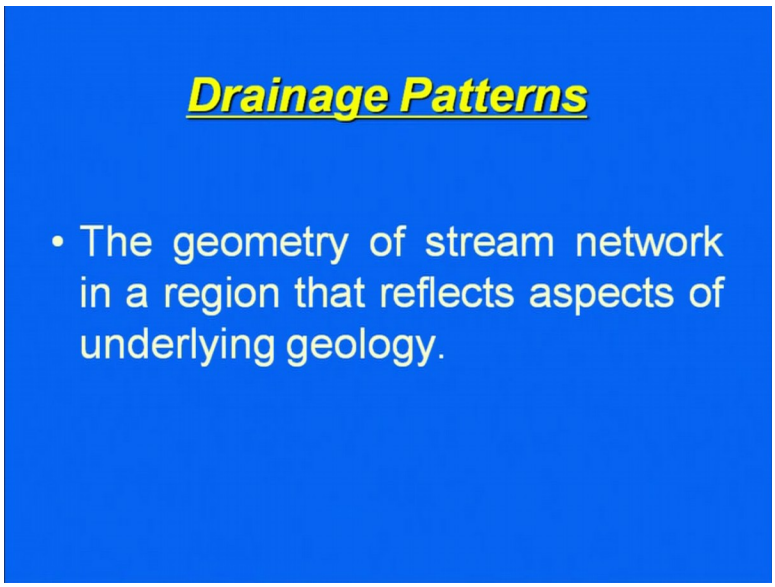

So, now, we are moving into a new topic where we are going to talk about the drainage pattern. So, until now, we have discussed about the channel pattern. So meandering, straight braided and anastomosing and Ana branching. These are all channel pattern. So now we are going to talk about the drainage pattern and drainage pattern as I told in the beginning also that it is controlled or is the manifestation of the subsurface geology.

So, let us see. So, the geometry of stream network in a region that reflects aspects of underlying geology. This is

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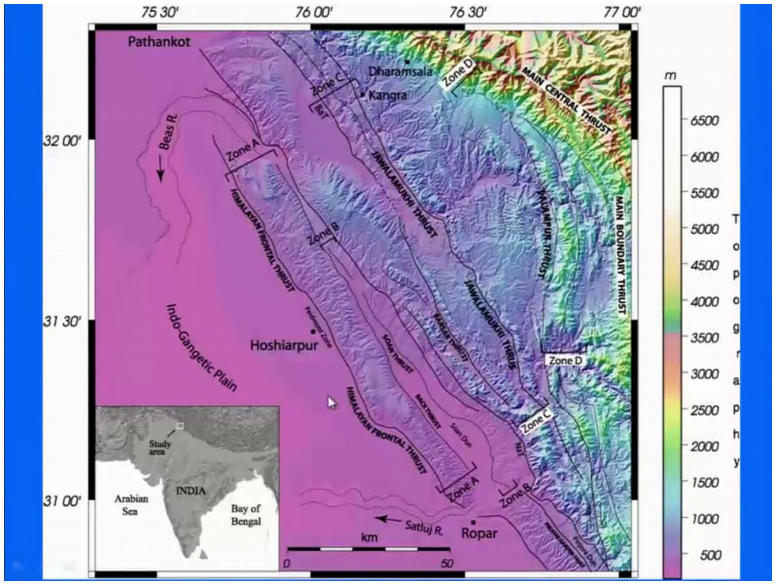

The shaded relief map of Northwest Himalaya. Where you can see the youngest mountain chain and multiple folded ranges across the slide, which starts from the schematics, youngest mounting chain in Himalaya and contact between the two plates. This Indo-Gangetic plain area and this is you are the played boundary which is marked by the rising hills of Himalaya to reverse which had the boating into him the Indo-Gangetic plain the major river Sutlej and Beas.

They are one of they are the major reverse is a divorcing into the into Indo-Gangetic plain. Again, both of them are intercedence streams and even they have cut through their flowing through the folded mountain chains here. So, they are whole antecedent's term and what is important part drainage pattern we are going to talk here is that if you carefully see then we have some sort of a features which are developed on the surface of fold here this is a longitudinal fold.

So, this the strike of the fold or the fold access is on the centre and the drainages are going on either action. Now, I am on the different directions. So, what we did was that this is an based on the digital elevation model, we extracted the drainage of this area

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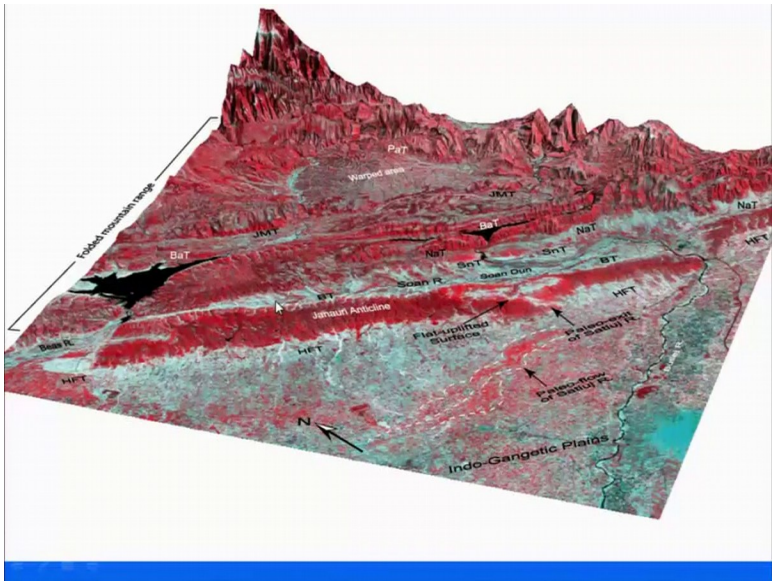

But before going to that figure, if you see this is a 3d prospective view of the terrain, which shows the contact between the Indo-Gangetic plain the Sutlej river coming out and Beas river over here. And there is the one, youngest mountain chain in this region. And then what you see here is devoid of some drainage, but the slope of war in this area and this area is in this direction as well as on the opposite direction. So, what we did was

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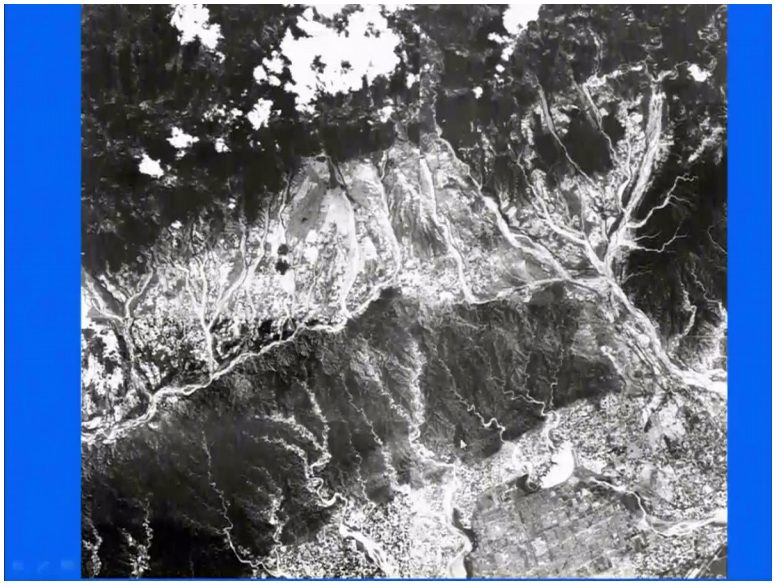

That this is again another photograph satellite photograph, which shows the drainage which are developed here. So this is an example of parallel drainage or drainage which are formed on the sloping surface. So, consequent drainage are developed here and then we have the channel which has been on the drainage is which are formed here and very fine tennis we can say because many tributaries are there.

So, this is also showing a different pattern whereas here also this is a different pattern of the channel of the drainage pattern basically. So, again we have the Indo-Gangetic plain the plain. The Himalayan front here. Now, what we did was

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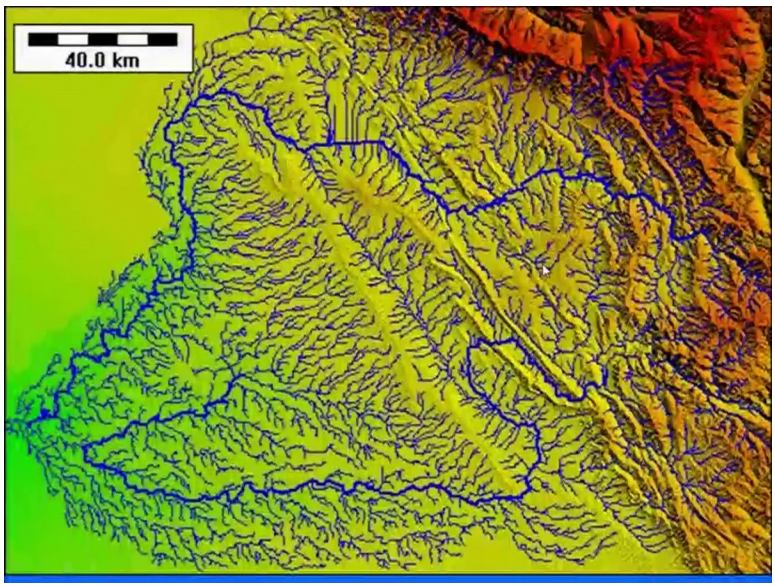

That we extracted the drainage from the digital elevation model. And what you see here is the darker, broad thicker line is the main stream, which is the trunk stream and then the smaller tributaries are joining. So this is the tributary for joining the Sutlej River and these are the tributaries which are joining this Sutlej River. Similarly, this is one tributary which joins the Beas River.

So, Beas River originated in the higher Himalaya's as whereas Sutlej originates in the higher Himalayas flow across the mountain berets and devotion to the Indo-Gangetic plain and as I was talking about that, there is the frontal fold. So, if you take only this example, what it shows is this is the demarcation line and this is the divide or the ridge line which separates the two-drainage is on either side.

So, one is flowing in this direction other flowing is this is this the other direction and this is the ridge line or the drainage divided and even the smaller drainage divide you can mark here in this area So, major streams which are flowing and shown by the darker blue lines, and the smaller one are the tributaries, which are flowing and joining the major transiting. Similarly, over here, if you see, this area is again an important one.

Which we will go back in and see the 3d prospective view. The drainage are flowing, in low all directions once the drainage is coming out here, flowing in this direction. Drainage flowing in this direction, and drainage flowing in this direction, this direction and this direction. So, what does this indicate that this central portion is about the area. So, if you look at the previous slide.

Then you will realize that this region is slightly wat area. So if you see here, this area, what we were looking in the drainage base, the drainage is which are flowing in all directions. So, this is another example of the uplifted or the up domal area, which was identified in the uplands or close to the higher Himalayan region. So, this is everything will be reflected. So, even the geology and the structures.

Which are present geological structure present beneath or subsurface, the based on that the drainage will be formed drainage pattern will form. So,

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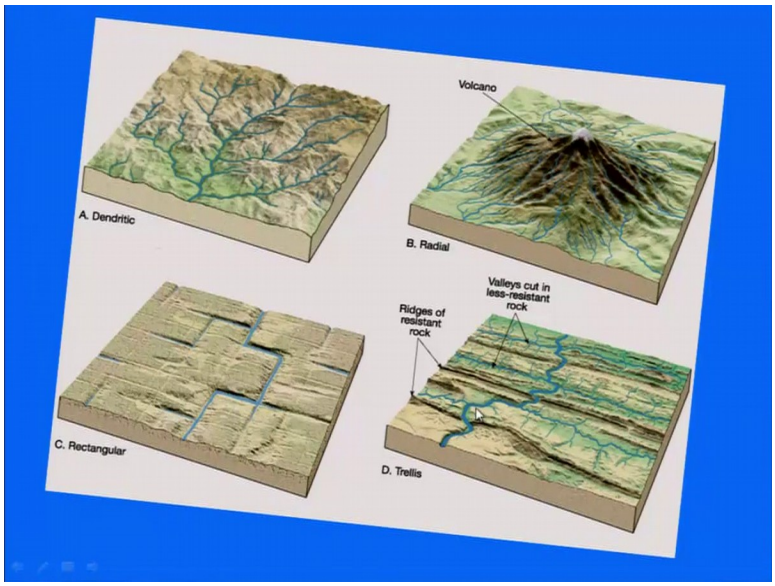

In common most commonly found drainages are dendritic drainage, then you have radial drainage, rectangular drainage and trellis drainage and how they are classified, we can see easily This is wounded on is homogeneous geology if you have then you will be able to see the tray the dendritic drainage, whereas, the radial drainage is if you are having dome structure.

As we were looking in the previous slide, so, if you are having the elevated portion in the centre and sloping surfaces on either side will result into the formation of radial drainages if

you are having the fractured rocks and if you are having an high angle or maybe the fractures that almost right angle then you will be able to see the rectangular drainages and trellis drainage are formed.

Where you will have the flow which goes across are the drainage which flows across the folded mountains are the folded terrain and the tributaries flows along the longitudinal strike of the fold and joints almost at right angle. So, Valley cut in less resistance rocks will be seen as the tributaries which are flowing almost perpendicular and then main Tran's stream will be flowing across the ridges or the folded ridges. So,

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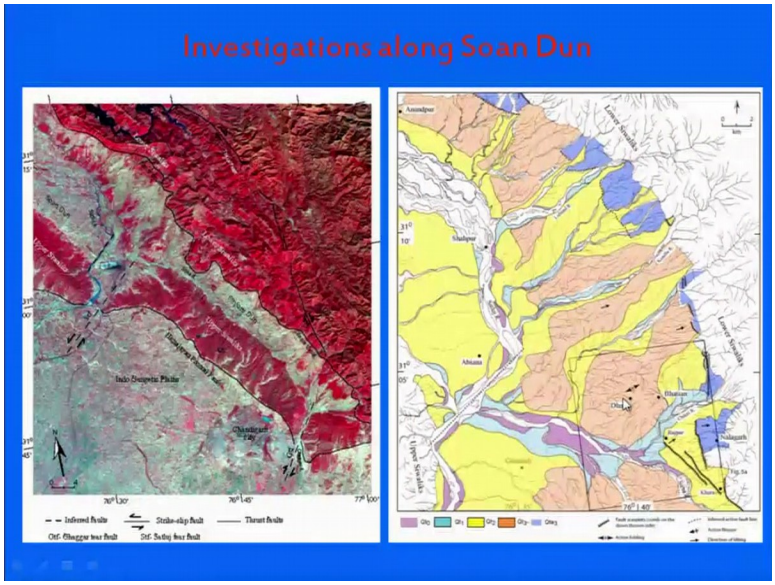

This is what we did and we also the investigation along the Soan Dun this is an area which is close to the Chandigarh city here and again the Lancet shows the folded mountains across the Himalayas. So, this region we surveyed and what we found was at there is again this we never resisted in the field but based on the drainage, when we came we identified the fold here, which was not expected and based on the drainage.

We have we were able to easily identify the drainage has been flowing in all direction here. So, now, if you look at this, this area, which is occupied by the region is occupied by the chivalric section, as well as the younger Cortana resection. So,

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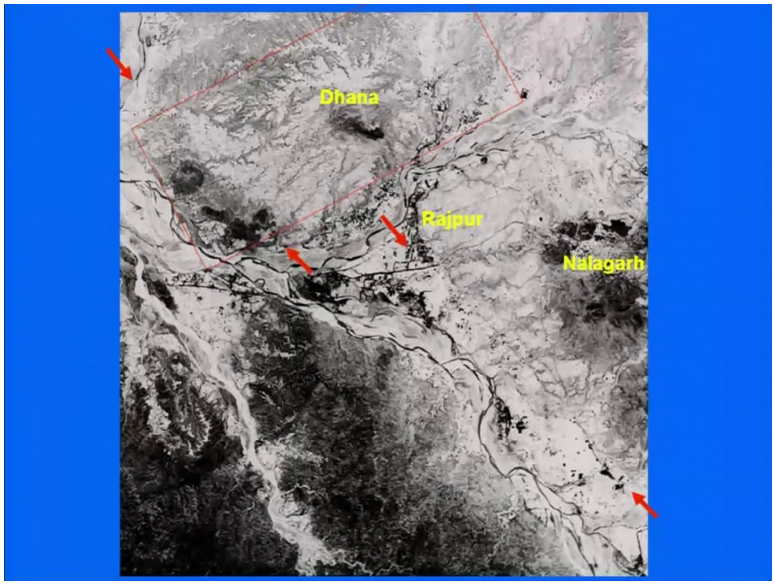

This is the terrain, the succession, which is occupied by the terrain. And the close up if you look at this area, which I was showing in the previous slide, the drainage is flowing on either direction. So, this portion is a walk portion, which is because of the fault line, which is marked by the arrows here. So, this fall along with the deformation has been taking place resulting into the warping of this area.

So, this was a very young deformational feature which we identified and let us see the feel for a diagram of this for the field photograph of this.

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What we were able to find is the sloping surface. So, this is a central portion is elevated and on the right bank of reverse what we found Chinky River. So, this is the field example or the field expression of the radial drainage which we saw. Now,

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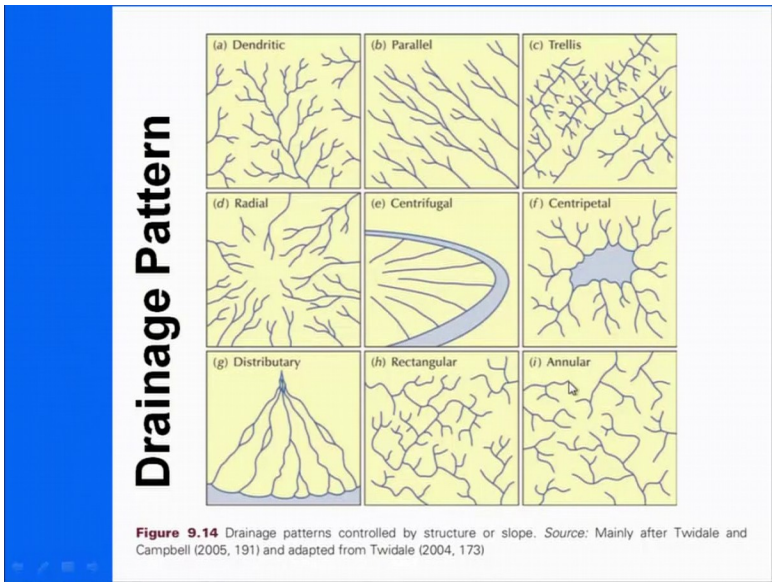

The further if you look at the drainage pattern, then we have several such drainage pattern, which is mainly the reflection of the subsurface geology and structure and slope in the reach as a main subsurface. So, mainly the geology and the geological structure plays an important role in manifests in the manifestation of the drainage pattern on the surface. So, you have dendritic pattern you have parallel pattern. Trellis pattern radial centrifugal, centripetal, distributary, rectangular, annular. So, these are the list

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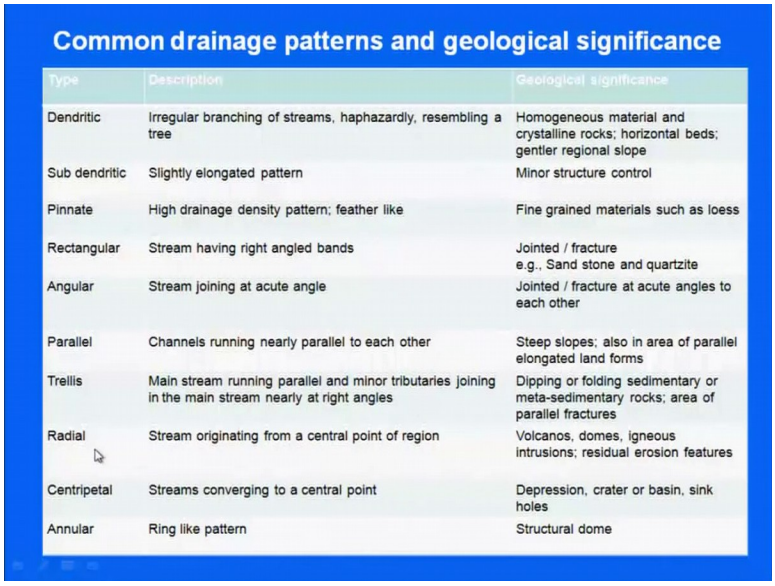

Type	Description	Geological significance
Dendritic	Irregular branching of streams, haphazardly, resembling a tree	Homogeneous material and crystalline rocks; horizontal beds; gentler regional slope
Sub dendritic	Slightly elongated pattern	Minor structure control
Pinnate	High drainage density pattern; feather like	Fine grained materials such as loess
Rectangular	Stream having right angled bands	Jointed / fracture e.g., Sand stone and quartzite
Angular	Stream joining at acute angle	Jointed / fracture at acute angles to each other
Parallel	Channels running nearly parallel to each other	Steep slopes; also in area of parallel elongated land forms
Trellis	Main stream running parallel and minor tributaries joining in the main stream nearly at right angles	Dipping or folding sedimentary or meta-sedimentary rocks; area of parallel fractures
Radial	Stream originating from a central point of region	Volcanos, domes, igneous intrusions; residual erosion features
Centripetal	Streams converging to a central point	Depression, crater or basin, sink holes
Annular	Ring like pattern	Structural dome

Which have been given of the different drainage type and the description like for example, if you are having talking about the, dendritic pattern and what it shows is that is an irregular branching of streams, haphazardly, resembling tree homogeneous material, crystalline rock, horizontal beds. So, mainly the geological structures what you will be able to see are the

listed here and gentler slope. Sub dendritic slightly elongated pattern minus structural control will be seen and then so on.

We see few of these channels, but please go to the stables this will be important and you will be able to remember for example, we were talking about the parallel drainages in one of this slide from the Himalayan region, so, channel running nearly parallel to work each other. So, parallel drainages are mostly the channel runs parallel to our flows parallel to each other and they are developed along the steep slope.

Now, this slope could be because of the natural or tectonic slope also. Then trellis pattern the mainstream runs parallel or minor tributaries joints from the steam. So, this is the flowing across the folded sedimentary terrain radial as we were looking at the previous example. So, we will have the domal areas or the residual erosional features or due to the formation we have the walking.

So, two examples we saw of radial pattern also one from higher Himalayas from Canada Valley whichever showing for in 3d prospective view. And another one close to the River Bridge is close to analogous that was mentioned in the previous slide. So,

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I will stop here and we will continue in the next lecture and see it some details about this as well as talk about some flood related hazard in this topic and the importance of the other drainage network. Thank you so much.