Geomorphology
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Lecture-50
Fluvial Process-VI, Drainage Patterns

So, friends, welcome to this lecture series of geomorphology and today we will continue with this fluvial process, particularly the drainage pattern. So, if we summarize the last class, here, the drainage pattern that we are discussed, it is there are 2 types. One is basic type and modified basic type. Basic type means that from 1 drainage pattern to another drainage pattern we can identify we can distinguish easily but modified basic it is within a basic type, there will be certain modification. So, that is called modified basic type.

For example, if we say it is a, the dendritic drainage pattern and sub dendritic drainage pattern, dendritic drainage pattern means you can distinguish the dendritic from the surrounding either trellis it may be some radial or something else. So, that means, in the first look at first instance, you can distinguish a particular type of arrangement of drainage or arrangement of channels from the other parts or from the surroundings and modified basic means, within that particular types of example, dendritic pattern.

There will be some parallelisms some local parallelism will be there some local radial drainage will be there. So, that means it is within that, so, that is called modified basic. So, today or in this class, we will discuss about the different drainage patterns that how these drainage patterns are useful in interpreting the subsurface interpreting the climate the tectonic process, they faulted jointed folded rocks or it is uniformly dipping uniformly sloping surface and it is alluvium or hard rock porous imporous impervious rocks.

So, that means, the geological characteristics of the subsurface as well as the geological characteristics of this climate, climate component how it is arid zone in drainage it is a humid zone drainage. So, depending upon the drainage pattern by looking these drainage arrangements

distributions, we can say about climate we can say about tectonism we can say about lithology will be a slope is faulted folding or whatever with the geological structures are there.

So, all these things can be interpreted from this first look or drainage analysis and by looking at the drainage pattern, so let us start with the most common type of drainage pattern that on the earth surface, what is called dendritic drainage pattern, it is the most common one most common drainage pattern everywhere

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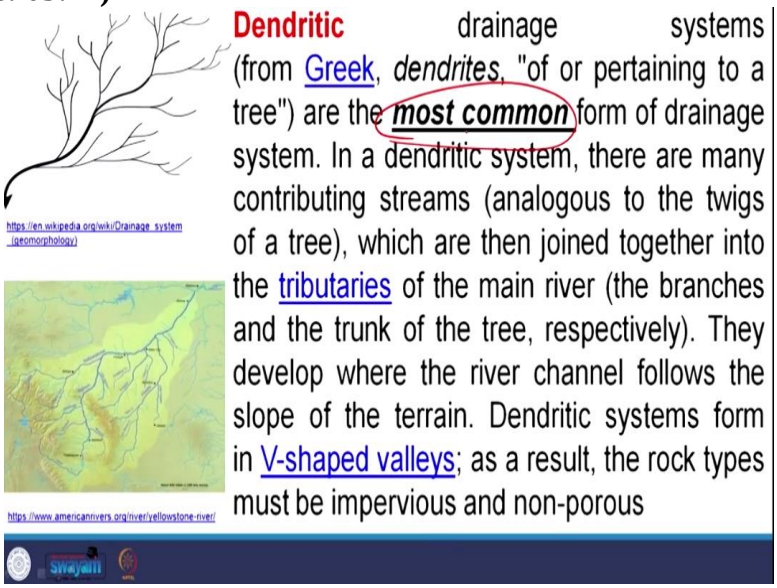

And it is present and the dendritic this term it is from the Greek word it is dendrite and it is like a tree. So, this is the ideal figure of a dendritic drainage pattern. So, if you see here, these are looking like branches of a tree and they are meeting the trunk river or the main this is the trunk river or the main river and each Tree branch, it is meeting to this trunk river. This is showing the dendritic drainage pattern.

So, they develop where river channel follows the slope of this terrain dendritic systems form in V shaped valley as a result, the rock types must be impervious and non porous. Here the geological interpretation is there, the rock type will be impervious and non porous, non permeable. So, it is a flat as it is basaltic terrain or it is a granitic terrain or it is any terrain which is gentle slope, and it is mostly imperious an impermeable rock. So, that is why a number of streams in the surface will be more and that is why the surface drainage will be more as compared to subsurface percolation.

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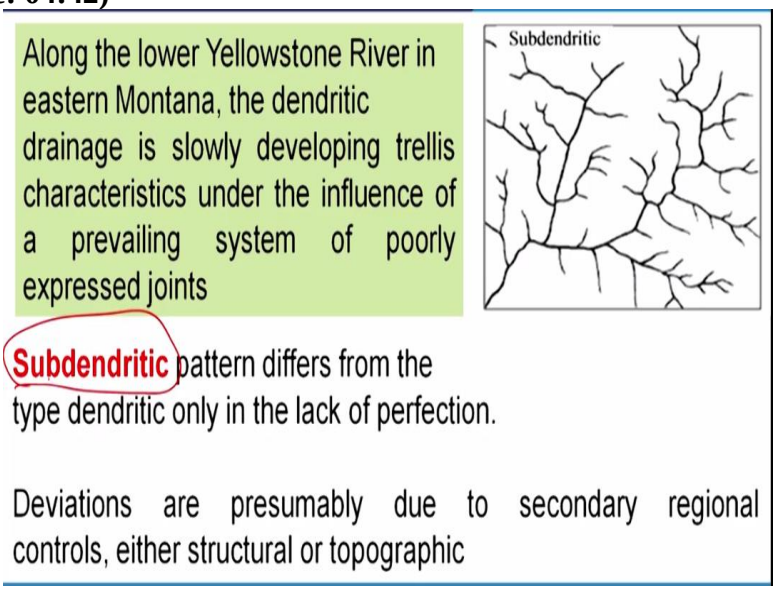

So, here there is some modification that is called sub dendritic that means the whole river system or the whole channel system drainage system it does not show, purely of dendritic characteristics that is why it is called sub dendritic for one example is there along the lower Yellowstone River in eastern Montana, the dendritic pattern is slowly developing trellis characteristics slowly living trellis characteristics under the influence of a prevailing system of poorly expressed joints.

So, that means, sub dendritic means is if you see here, this is showing to trellis characteristics. So, that means, though it is totally dendritic system but locally, there are certain parts certain regions, they are showing trellis patterns similarly, somewhere some local part may show some other pattern also so, that means the whole drainage system it is not of dendritic characteristics. Therefore, it is called sub dendritic.

So, it is modified basic basic is dendritic pattern, sub dendritic is modified basic pattern deviations are presumably due to secondary regional control either structural or topography. So, here this local changes local deviation may be structurally may be topography. So climate cannot have because climate effects in large area you cannot say this river or this part of the river is a climatically affected then this part is tectonically affected no.

And so that is why when we are talking something about local changes within the drainage pattern as well if you remember in the last class we are talking about the drainage anomalies,

anomalies mostly they are tectonically attributed technic, tectonical influenced. Similarly, here this local changes local modification from the basic type, the sub this is sub dendritic pattern it is either due to this is secondary regional control, either structural or topographic so structure and topography. They affect locally to modify the basic pattern to this modified basic pattern. Then, the second type of drainage we will discuss about the pinnate.

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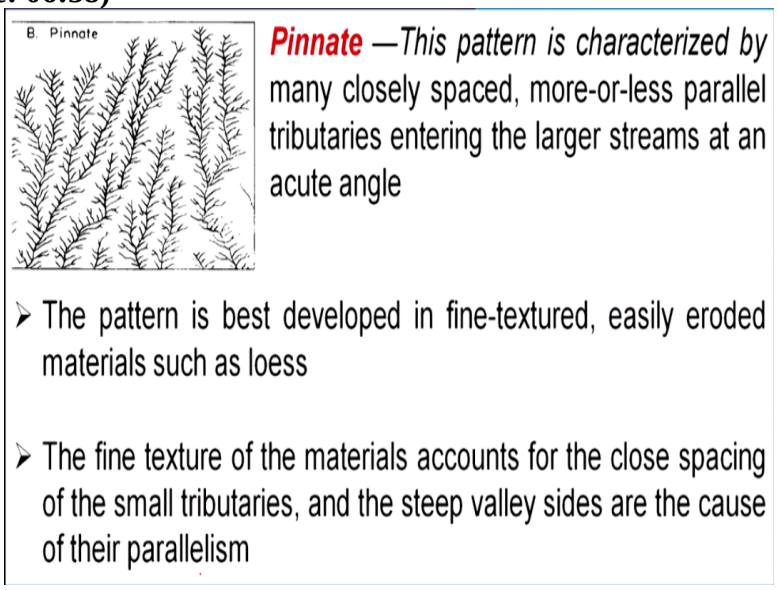

Pinnate it is the pattern characterized by many closed spaced more or less parallel tributaries entering the large streams at an acute angle here if you see this figure, it is very closely spaced drainage, and there are more or less parallel to see these, these tributaries are more or less parallel tributaries, they are entering an acute angle to the main drainage this pattern is best developed in fine textured, easily eroded materials such as loess.

So, here is the interpretation, it is fine texture material, it may be loess, it may be fine sand, silt, fine textured material, easily eroded material again, they are easily erodible. So that means gully type of appearance that means gully type of development will be there is a or there is a gully or gully type. That means we remember our last class we are talking about this rills gully and valleys.

Mostly it is gully type of appearance and here fine texture will be there and more erodible material will be there. The fine texture of this material accounts for close spacing of these small tributaries and steep valley sides are the cause of their parallelism. So again the geological

interpretation. Once we said it is fine textured, that means it is closed with this fine texture material that will account for close spacing of the drainage and parallelism.

It is due to steep slope see more the steeper slope, the more parallel the drainages are. So here we remember in last class we are talking about this a piedmont zone, that Himalayan piedmont or any piedmont zone worldwide if you move them so steep slopes and these steep slopes, they are show parallel drainage pattern. So this parallel drainage patterns, their characteristics of slope and the mostly it is steep slope. So parallel drainage pattern. So here we have parallel drainage pattern. That means indicating it is a steep slope. Then we have fine drainage pattern, very fine drainage pattern that indicates it is a finer and easily erodible material like loess.

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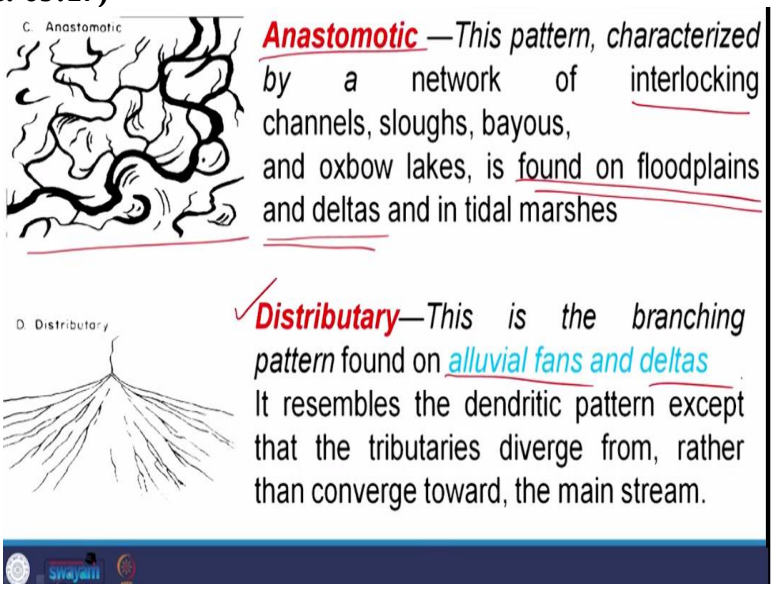

Then anastomosing river system and anastoming river who last class we are talking about like channel habits anastoming that means, this channel is bifurcated or multiple channel out, there this channel they enclose or permanent islands and this channel remains stable you see similarly it is anastomotic dendritic pattern, it is characterized by a network of interlocking channels, sloughs and bayous and oxbow lakes is found in floodplains and deltas in tidal marshes. Floodplains it is very good example is the Ganga flood plain.

If you see this satellite imagery of Bihar area, mostly the eastern Bihar, you will find these type of structures very, well preserved systems it is there in the satellite imagery due to frequent migration of rivers if you 1000 oxbow lakes hide 1000 of paleo channels are there. So, here it is

the characteristics is interlocking channels sloughs bayous and oxbow lakes it is found in floodplains in the and in deltas and in tidal marshes.

So, this geological interpretation is, it is called which is found in floodplains and tidal marshes in delta area. Then another type of drainage pattern is the distributory pattern distribute means a term itself says it distributes that means the main channel distributes it water through distributed channels sub channels. So, these are mostly found in alluvial fans and deltas so alluvial fan and delta they are the characteristics the transportation of distributed pattern.

So, here alluvial fan and delta is there it resembles the dendritic pattern except that the tributaries diverse from rather than converge towards the main stream. The difference is that in a drainage pattern like the dendritic where the tributaries, the converge in the main stream, but here, these distributories that diverge from the main streams, then parallel drainage pattern, parallel drainage pattern again a few minutes back were talking something about it is talking about the relief the slopes, higher the slope, higher the parallelism.

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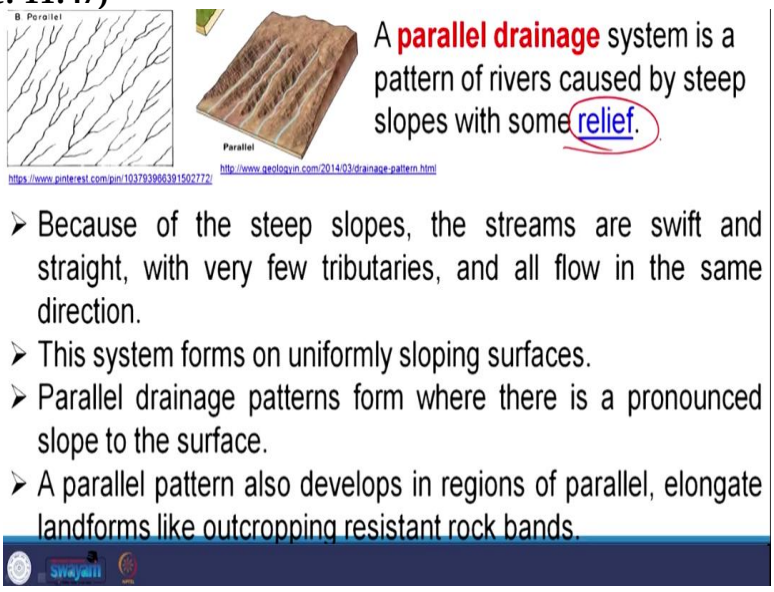

So, this parallel system is a pattern of river caused by steep slope with some relief steep slope here, if you see this block diagram it is given, it is slope is like this, so, you see this parallel drainage pattern are there so steep slope with some relief will be there because of the steep slopes, the streams are swift and straight with very few tributaries and all flow in the same direction.

This system forms uniformly sloping surface parallel drainage pattern form where there is a pronounced slope in the surface. A parallel pattern also develops in the regions of parallel elongate landforms like outcropping resistant rock bands. So, here when there is a alternate hard and soft rock, so, soft rock will easily erode and it will accommodate a channel within that and hard rock will remain resistant and it is a ridge.

So, this type of parallel drainage pattern also it is seen in the regions were alternate hard and soft rocks are exposed. So, this is a geological interpretation first it is should be steep slope with some relief. And second interpretation is maybe due to alternate exposure of hard and soft rocks. So, but the main thing whether which region is the most one, it will be studied in the field examine field.

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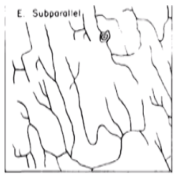

Subparallel—*The* subparallel pattern (*Zernitz*, 1932) shows less parallelism than the basic pattern

- If due to slope alone, the pattern resembles that formed by the branches of a poplar tree.
- Where due to mild structural control by deformed strata of relatively uniform resistance to erosion, there is sufficient parallelism among segments of the main streams and tributaries to suggest the bedrock control, but streams commonly diverge from the geologic grain.

Then sub parallel that means parallel is the basic and sub parallel the modified basic the sub parallel pattern. So, less parallelism then it is the basic pattern, it is shows less parallelism. If due to slope alone, the pattern resembles that formed by these branches of a poplar tree where due to mild structural controlled by deformed strata of relatively uniform resistant to erosion. That is sufficient parallelism among these segments of this main stream and tributaries.

Suggests the bedrock control, but streams commonly diverge from the geologic grain. So, here this sub parallelism that means, it is not perfectly parallel but resembles to parallel here for example, if you see these streams, they resemble parallel but not exactly parallel.

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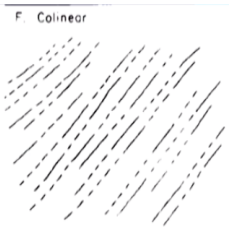

- **Colinear**—This pattern *(Zernitz, 1932)* is characterized by remarkably straight parallel streams or channels which alternately disappear and reappear.
- The pattern is found in areas of linear loess and sand ridges.

Then collinear means in the same straight line collinear same line. So, here if you see this drainage, somewhere it is exposed and somewhere it is not exposed to the surface. So, that means, within a line of drainage within a line of channel, some part of the channel is exposed and active and some part is not exposed, that is within that surface subsurface. So, this pattern is characterized by remarkably straight parallel streams or channels.

Which alternative disappear and appears here this key factor is there alternative disappear and appear. For example, here for here, this is appear and in this is white portion disappearing, similarly, the black line is appearing and the white portion is disappearing. So, within a straight line appearing and disappearing appearing disappearing, appearing disappearing. So, this type of drainage pattern it is called collinear drainage pattern.

This pattern is found in the areas of linear loess and sand ridges, loess and sand ridge if you see loess, it is porous and permeable and the sand is porous and permeable. But loess it is porous but not permeable. In that cases if you have alternate sand and loess. So, in that case, so that sand clay, so, this sand the clay alternative sequence is there. So, in that case you will find in the clay part in this though it is porous but not permeable.

So, water will not percolate down it will be on the surface, but in sand regions, this is porous and permeable. So, water will percolate down and there will be disappearing substrates. So,

alternative loess and sand ridges if it is there. So, you will find such type of collinear drainage pattern.

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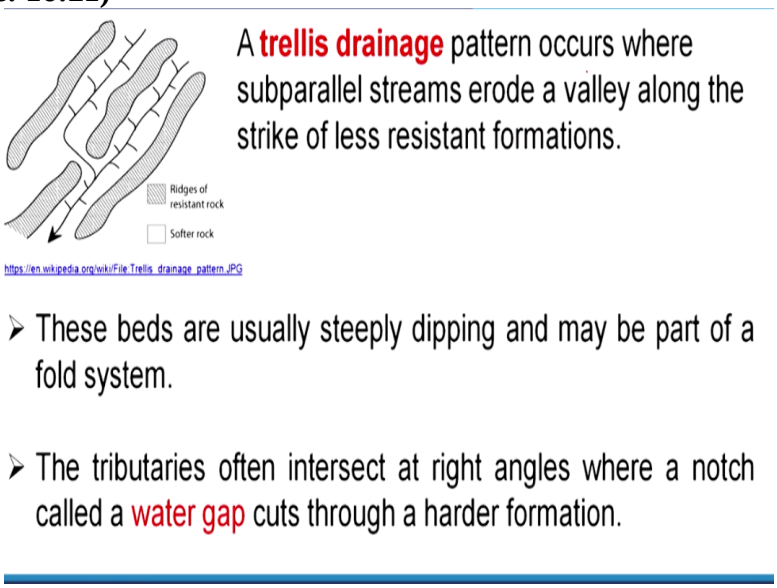

Then another is your trellis pattern, trellis pattern this occurs where is sub parallel stream erode a valley along the strike of this less resistant formation. Here if you see these are the ridges this shaded areas the resistant ridges and these are soft rock. Now see these soft rocks they can easily erode and will accommodate streaming bed inside really accumulate and it is hard rock this is hard and this is hard. So, there will be steep slope gradient there, steep slope will be there.

So, due to the steep slope, you see this type of parallel streams they comes from the steeper area and adjacent to the mainstream. So, this pattern is called trellis pattern. These beds are usually steeply dipping and may be part of a fold system. The tributaries often intersect at right angle where in notch called water gap cuts through a harder formation this is called notch or water gap here the streams are meeting similarly.

If we will be there, here will be the water gap stream may come here and meet here. So, trellis pattern in this indicates it may be folded it may be alternate arrangement of this hard and soft rock and the hard rock remains as resistant and it is steep slope. So, due to the steep slope small tributaries, they originate from these steeper slopes and meet the mainstream at right angle.

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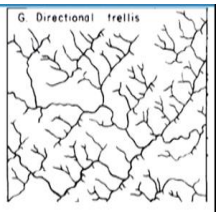
- **Directional trellis** —This term is suggested for a modification of the trellis pattern in which the tributaries to the long subsequent streams are consistently longer on one side of the valley than on the other



- The pattern most commonly is found in areas of gently dipping homoclinal beds, but also occurs on gentle slopes with parallel beach ridges.
- **Subtrellis**—The subtrellis pattern differs from the type trellis only in the degree of continuity and parallelism of the dominant drainage. Distinction between subtrellis and subparallel is commonly a matter of judgment.

Then within the drainage pattern, there is some modified basics trellis is the basic pattern modified basic is one is called directional trellis directional trellis that means, it is indicated it is in one direction, directional trellis. This term suggested for a modification of the trellis pattern in which the tributaries to the long subsequent streams are consistently longer on one side and in the valley than the other.

For example, if you see here in this figure, it is a directional trellis that means, one side of this see this is the mainstream and these are the tributaries this side the tributaries smaller. However, this side tributary is longer similarly this side tributary is longer this side is smaller. So, that means it says here, this side is longer and this side is smaller. So, that means it says though it is a trellis pattern, but one side of this tributaries are much longer as compared to the other side.

The pattern most commonly is found in areas of gently dipping homoclinal beds, but also occur on gentle slopes which parallel beach ridges. Beach ridges, we know earlier classes were talking about this a coastal geomorphology so need not to talk much about this. So this type of drainage pattern, it is characteristics in beach ridges, as well as the tributaries, subsequent streams constant it is found in the gentle slope parallel beach ridges and homoclinal beds.

These are the geological interpretation then within the trellis another sub pattern or these modified basic is the sub trellis sub trellis means the sub trellis pattern differs from this type

trellis pattern only in the degree of continuity and parallelism of these dominant drainage. Distinction between sub trellis and sub parallel is commonly a matter of judgment. So here the geologists test to decide on which category he or she has to put this drainage pattern.

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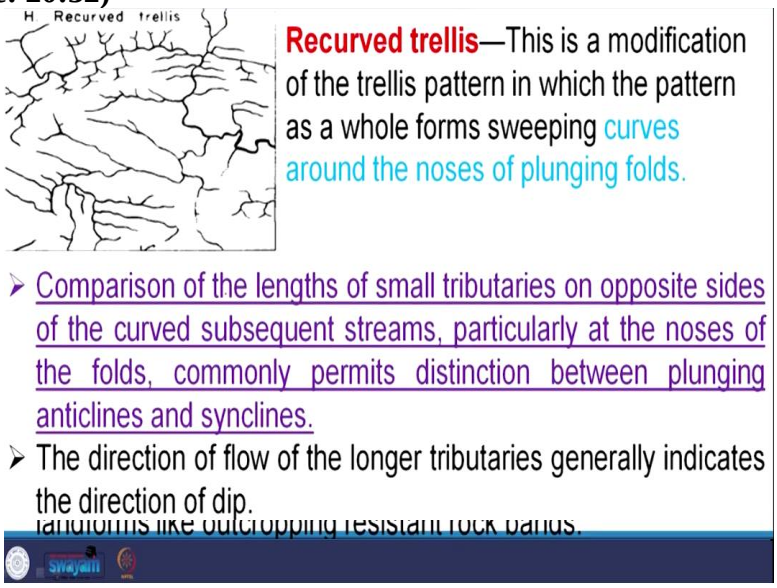

Then it is called curved trellis, curved trellis means this is a modification of the trellis pattern in which the pattern in which the pattern as a whole form say sweeping curves around the notches of plunging folds.

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For example, here if you see is a plunging fold, and the drainage system is like this. So the drainage that will here it will modify like this they will continue drainage itself will fold like this. So, this is a pattern here, it is a modification of this trellis pattern who is the pattern as a whole

forms sweeping curves around the noses of a plunging fold. So, here if you see this is modify. Similarly, this is so, it is a noses of a plunging fold.

So, if it is folding like this the drainage system is curved like this. So, this is called curved trellis. Comparison of the length of small tributaries on opposite sides of the curved subsequent streams particularly at a nose of this fold commonly permits distinction between plunging anticline and syncline. So, you can distinguish you from a drainage pattern of this curve trellis you can distinguish whether you are dealing with the antiform or synform it is plunging antiform or plunging synform.

The direction of flow of this longer tributaries generally indicates the direction of dip or direction of plunging at the direction of plunge of this fold. So, here if you see here, this drainage you see it is flowing in this direction, it is flowing in this direction and it will curve somewhere here it is curve somewhere here, will curve somewhere here. So, these direction of flow is towards the plunge of this fold. Similarly, here if the drainage pattern is developing for example, if you see here, this is these are the drainage pattern develops. So that meant it indicates this is a plunging fold and plunging to this direction.

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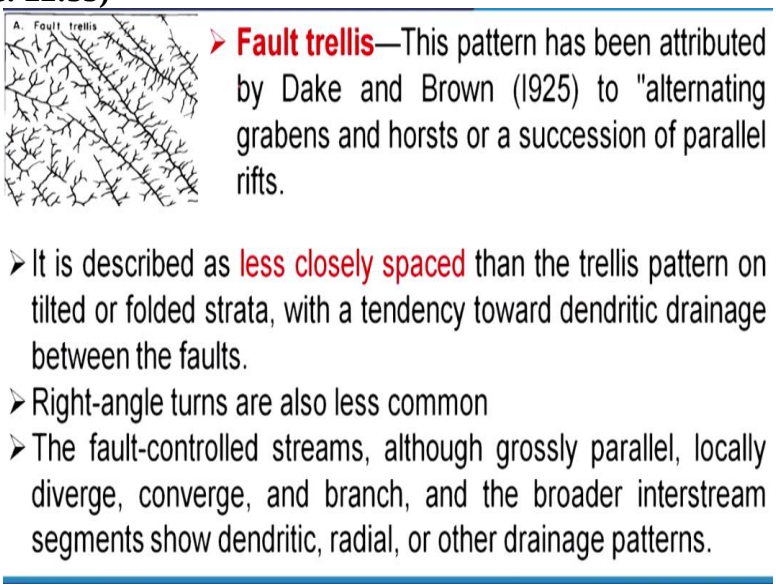

Then, another type of trellis pattern is a modified basic type is fault trellis that we have fold trellis that is curve trellis. Similarly, we have fault trellis so that means it is a trellis pattern, but it is controlled by fault for example, if you see this, this pattern has been attributed by Dake and

Brown in 1925 to alternate grabens and horsts of succession of parallel rifts. So, we have horst and graben so horst and graben so we know graben there are depressed part it is bounded by normal fault and horst there in uplifted block bounded by 2 normal faults from both sides.

So, that means we alternate we have ridges and basins and we are generating here this fault trellis that means it is a fault are their fault graben horst that means always normal fault is associated. It is describe as less closely spaced, then the trellis pattern on tilted or folded strata, which tendency towards dendritic pattern between these fault. The right angle turns are also less common, the fault controlled streams although grossly parallel.

Locally diverge converge and branch and the broader inter stream segments show dendritic radial or other drainage patterns so, these are the characteristics within this within the horst and the garbens. So here, these streams, they are totally fault control so wants, they are fault control we have a horst that garben. So, grossly they will so parallelism, but they locally diverge converge and branch in the broader interstream segments.

So dendritic pattern, radial patterns and other stream patterns within the interstream segments. They can so, different type of stream patterns, but broadly they are parallel to each other. So they are fault control and this parallelism that depends upon the length of the fault to what extent the fault is continued. Then another type of modified basic of trellis pattern.

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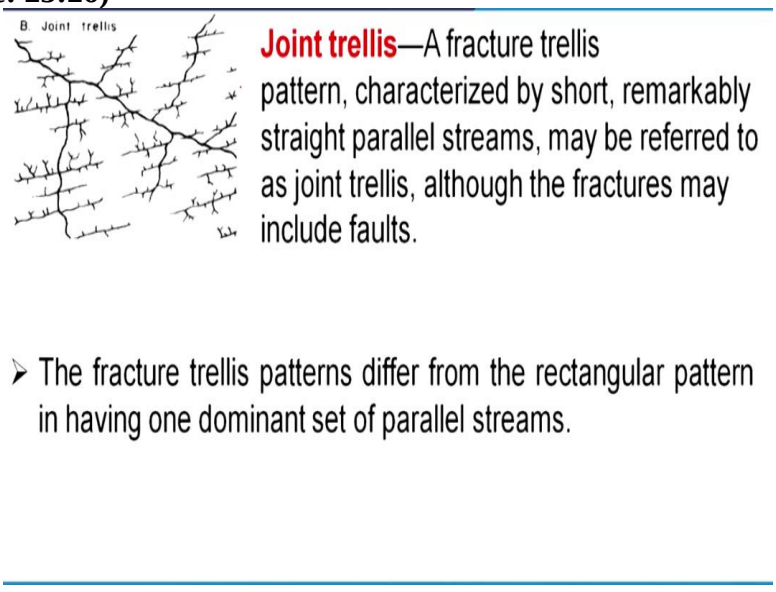

It is the joint pattern are these joint trellis, joint trellis a fracture trellis pattern characterized by short remarkably straight parallel streams may be referred to as joint trellis, although the fracture may include faults also. So, here, if you see these are these joints, that means one set of joint for example, it is nearly east west. For example, here if this is we consider north so, here it is east west joint sets are there.

Similarly, another set of joint it is coming here another set of joint is coming out. So, that means here this trellis pattern is developed due to the joints of rock the fracture trellis patterns differ from the rectangular pattern in having 1 dominant set of parallel streams, 1 dominant set of parallel streams there.

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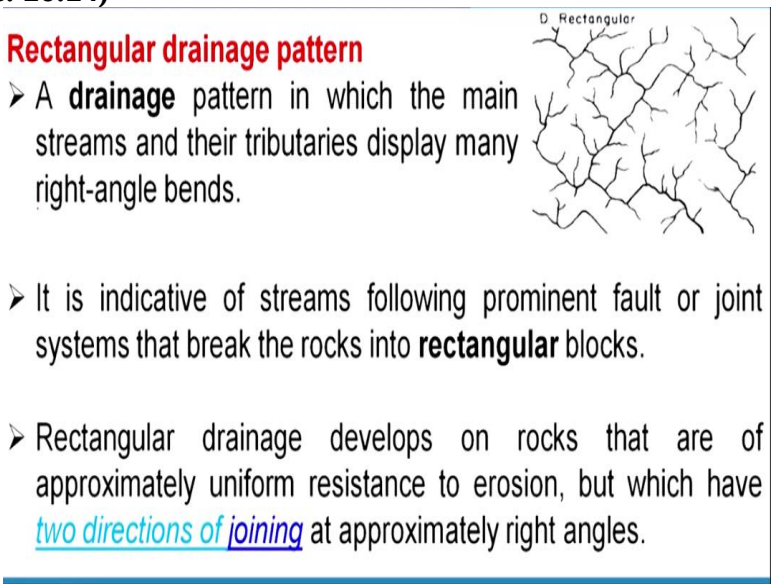

Then another type of drainage pattern that is called rectangular drainage pattern. Rectangular means, this rectangle itself tells is looking like rectangle for example, here if you see, this is a rectangular pattern. Similarly, here it is rectangular pattern. So, this rectangular pattern that means it is also structurally controlled. If 2 sets of joints are there, 2 sets of joints they are cross cutting each other at right angle to each other.

So, this type of drainage pattern can develop so here is a drainage pattern in which the main streams and their tributaries display many right angle bends. So, this right angle bends. So, it is indicative of streams flowing prominent fault or joint systems that break the rocks into

rectangular blocks. So, either it is fault system 2 different sets of fault 2 different sets of joint which are perpendicular to each other.

This type of drainage pattern will accommodated they are rectangular drainage develops on rocks that are of approximately uniform resistance to erosion, but which have 2 directions of joining at approximately right angles. So, here the interpretation is there. So, here uniformly resistant rock to erode. So, one courtesy is there another courtesy, which is structural control that means 2 perpendicular joint sets or faults, they are controlling the whole drainage system. As a result, here, you will see the rectangular bends, rectangular bends are there.

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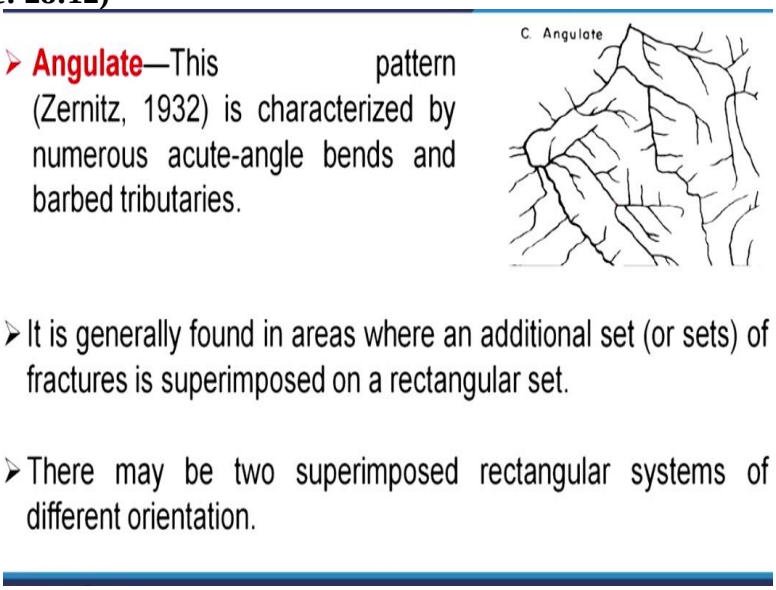

Then angulate, angulate means angle. So, this pattern is characterized by numerous acute angle, bends and barbed tributaries. So, here acute angle bends are there, if you see here, this is acute angle bends. So, this is angular types acute angle when you see here, this is bending. So, this is generally found in areas where an additional set of this fracture is superimposed on a rectangular set. So, here we have rectangular set and on this rectangular set we are superimposing, another set of joint.

Which is at an angle to that, so, there may be 2 superimposed rectangular system on different orientations. So, that means, if the drainage system is structurally controlled, we are getting a directional trellis pattern. So that means at particular directions they are confined, and the direction is defined by the structural system is defined by this fault pattern defined by this joint

orientation, different set of joints, either they are parallel to each other, perpendicular to each other, or they are superimposed joints.

So, that means structure, we can interpret lithology we can interpret slope we can interpret from this drainage pattern. That is why drainage pattern is an important parameters in tectonics geomorphology rather in geomorphology, to say, what type of terrain you are dealing with so I think we should stop here. We will meet in the next class. Thank you.