Plate Tectonics

Prof. Pitambar Pati
Department of Earth Sciences
Indian Institute of Technology, Roorkee

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Conservative Plate Margin- IV, Continental Transform Faults

Okay friends, welcome to this plate tectonics's class. And we will continue to this discussion continental transform faults. So, if you remember our earlier class, we are talking about this continental transform fault once developed in the continent may transfer to ocean and ocean-continental transition and finally, to the ocean reaches. And the Ghana Ivory Coast margin and this San Andres faults are the two continental transform faults that we have been well studies and this Ghana Ivory Coast margin is the continental transform fault margin. So, today we will talk about how these continental transform faults are distinguished, what are the geological features that are there by which we can study or we can identify or you can distinguish the continental transform fault. What is the topography? What is the structure? What is the geology? And all these things we will discuss in this class.

So, this continental transform fault, their style and their physiography. So, these are the linear fault scraps and laterally offset surface features. If you see this block diagram here, this is a continental transform fault and you see this is a linear depression and it is one side it is high topographic area, another it is low topographic area and there is lateral offset and large continental strike-slip fault typically display linear scraps and troughs. How the linear scraps and troughs are defined? If you see here, we have a linear scrap surface here and as this is the fault zone that means, here there will be crossing of rocks.

Crossing of rocks means that is fault breccia and this is a weak zone so that there will be very prone to erosion. So, that's why by erosion this part will be removed. So, once it is removed it will be a natural trough developed. So, that's why it is defined by linear scraps and troughs that result from differential erosion of juxtaposed material and this erosion of fault gouge that we have already discussed and the age and magnitude of this offset determine this slip rate so, if you have a transform fault it may not be possible that this slip rate remains constant throughout its lifetime. Somehow it is that means, the slip rate is high somewhere may be less.

So, that we can date those materials which are juxtaposed to each other and based on the dating and this length of offset that we can determine what was the different slip rates in different geological time. Then few terminologies associated with this transform fault one is step over, push-ups and pull-apart basin. What is step over? Now imagine we have a transform fault here and with continuation to that transform fault here we introduced another one, but both are not joined together. So, these are En echelon-type. So, in the En echelon type that means, the motion transfers from here to here and through this area which is overlapping with each other.

So, in most large strike-slip fault one active segment that terminates in proximity to another subparallel segment, motion is transferred across the intervening gap resulting the zones of localized extension or contraction. So, here if you see we have two transform fault one is dextral motion and here another is also showing dextral motion. However, the difference is that here due to dextral motion this side it is showing dextral motion and this area which is common in both they are showing extensional properties. However, due to dextral motion here this area which is common to both it is showing contractional property. So, that's why either it will be localized extension or it will be localized contraction that depends upon the type of motion among the two segments.

So, in these step overs the initial geometry and the sense of slip of this adjacent fault control whether the area separating them between extended or shortened. For example, here its initial geometry is a dextral one. So, this is also dextral one. However, this area which is in between either it will be representing a basin or it is representing a hill or it is a ridge that depends depending upon its either it is a contraction zone or it is a extension zone. So, this pull-apart basin here the normal faults and the extensional troughs they are combinedly called the pull-apart basin.

For example, if you see this block diagram here this is a transform fault which is curved in nature and now this block is moving this way and this block is moving this way so, once we are moving these two different blocks to different directions here we are creating a gap. However, here we are compressing the region. So, this gap which is forming here. So, two blocks are moving away from each other. So, if I am taking a cross-section from here to here two blocks are moving each other that means, we are creating some normal fault.

So, this is a zone which is introducing a normal faults they are facing to each other that means, we are creating a basin and that basin is called pull-apart basin. So, that's why normal fault and the extensional troughs are called pull-apart basin. So, this pull-apart basin is here where the two faults or sorry the two blocks they are moving away from each other and this area which is in between it is creating a gap. Thrust fault, fold and topographic uplift known as push-ups from where this intervening region is compressed. For example, here as I was talking to you this plate is moving in this way or this block is moving this way this block is moving this way.

So, if this is a zone where this fault geometry is like this. So, this zone it will be compressed. Similarly, this zone it will be compressed. So, that means, we are creating similar type of region where these faults we are developing due to compression there is thrusting there are thrusting. So, that means, reverse fault are developed.

Once one reverse fault is overlapping on the other reverse fault. So, this blocks or the rock blocks they are overriding with each other. So, due to overriding of the system we are creating a small ridge small hill here. So, these are nothing these are these push-ups. So, this push-ups and pull-apart basin that depends upon the direction of movement.

For example, here we are separating these two blocks from each other through this transform fault and we are creating a gap here that is the pull-apart basin. And here we are compressing the system and finally, we are creating a ridge that is the push-ups so, the push-ups and pull-ups they are representing the compressional tectonic regime and extensional tectonic regime, respectively. Now, to explain it we have three end members of the fault one is pure strike-slip, another is pure normal that is extension and it is pure reverse that is contraction. So, if it is here we have a pure reverse fault, here we have pure normal fault and here we have pure strike-slip fault. But in between suppose a fault or a block which is undergoing extension as well as strike-slip.

So, that means, extension component will be there and strike-slip component will be there. So, that the area in between that will be termed as transtension and if it is reverse fault is there that is contraction and it is strike-slip motion this area will be called transpression. So, this transpression and transtension that depends upon if it is extension that is called transtension, it is compression that is called transpression that depends upon either it is a compression or it is in extension. So, now, if you see this figure here this is transpression and transtension has been described and here this is the step-over you see how this step-over that means, is the extension system and here we are creating pull-apart basin and mostly if we extend this here. So, what we are getting that is there is the transtension that is pull-apart basin we are creating transpression sorry transtension and here this is the push-ups push-up that means, here that is contraction that is we are creating the strike-slip duplex that is restraining bend.

And similarly there is another type of strike-slip fault where this here what is these two strike-slip segments they are separated from each other. However here these two strike-slip segments they are not separated they are joined together and this moment is in this way this moment in this way. So, once we are moving in two opposite directions. So, what is happening that means, we are creating a gap. So, this gap it is nothing this is subsidence occur and finally we will able to create this pull-apart basins and here if we are pushing this way and we are pushing in this way.

So, that means, here what is this region where it is in the bending region you can say where this fault is bend. So, this region is experiencing compression. So, that's why here the compressional topography like a fold, thrust that will develop here the extensional topography like a normal faults, basins that will be developed and here this can be transferred or this can be transferred here and this can be transferred here. So, this is the extensional topography and this is the contractional topography and now if I am taking a cross-section here the cross-section will like this that means, we have extensional topography we have normal faults and due to normal fault this blocks are going down and here if I am taking cross-section here this reverse faults are developed due to compression and each reverse fault is moving up and finally, we are getting a positive topography here we are getting a negative topography here. here we are getting a negative topography here.

So, another two terminology called the releasing bend and the restraining bend. What is the releasing bend? Releasing means the term is itself self explaining release it is releasing the strain and restraining bend it is restoring the strain. So, that means, here it is represent the compressional system and here it is represent in the extensional system. So, in zones where the strike-slip faults are continuous the strike of these faults may locally depart from a simple linear trend following a small circle on the earth surface this circle once we say we are talking about the Euler small circle and in these area the curvature of the fault plane creates zones of localized shortening and extension according to this whether these two sides are bending or converge or diverge. So, that we have already discussed here suppose we have a strike-slip fault it is moving in this way and in this area if it is a bending of this fault is here this is fault geometry which is bending and here we are creating progressively normal faults and we are creating a basin and similarly here in this area we are compressing the system and finally, we are creating hills and this result is here this compressional system that is we are creating the hills and the extensional system we are creating the basins.

Then strike-slip duplex, fans and flower structure. So, here the same figure again. So, we are creating a basin here this basin here and look like it is a flower. So, that is if you see here a strike-slip duplex is nothing it is an imbricate array of two or more faults bounded blocks and that basins and that are in between two large bounding faults. So, we have two large bounding fault one is here another is here another is here and in between we have array of normal faults and we are creating a basin and this basin is bounded by normal fault in both side and we will have number of normal faults in between.

So, this is called this strike-slip duplex and the faults bounded basins that are characterized by duplex typically are lens-shaped as already it is shown here. The individual blocks defined by the strike-slip fault are shortened and uplifted when the fault converge and stretched and down thrown when the fault diverges. Already we have discussed if it is converging. So, it is stretched and up thrown blocks are there and if it is diverge that is extended and here this is the down thrown blocks are here and this structure it is called negative flower structure this structure is called positive flower structure. Why it is called positive flower structure? Because its topography is positive it is negative flower structure which is the topography is negative from the surrounding.

And now the question arises how this strike-slip fault that end whether it can circumference the whole globe no somewhere it has to end and at the end large strike-slip faults that displacement may be dissipated along this array of curved faults that link to the main fault forming an array of fans and you can say it is a called the horsetail structure or it is a fan forming a fan. So, now you see this strike-slip fault which is at the end it is dividing into curved fault so, it is like a fan in the geomorphic system. So, this is called fan or it is called normal that is called horsetail splays. So, this horsetail splays are here and we have strike-slip duplex is here and we have this is ridge, push-up ridge are here and this is the normal fault. So, En echelon normal faults are developed here.

So, along this strike-slip fault the topography varies the structure varies and the rock type varies because different generation of rocks different age of rock they come just opposed opposed with each other. And this flower structures that few minutes back we were talking about this one is called negative flower structure another is called is positive flower structure. Negative flower and positive flower is based on topography if it is surrounding from the surrounding this area is going down it is creating a basin due to normal faulting that is called negative flower structure and if it is with respect to surrounding this area is moving up and it is compressional system that is called positive flower structure. So, anyway it is looking like a flower it is looking like a flower that's why it is called flower structure and negative positive is based on this topographic appearance so, now the another terminology is called strike-slip partitioning this is transpression and transtension. What is strike-slip partitioning? For example, suppose there is an oblique-slip fault and oblique-slip boundaries for example, and oblique slip boundary so that means, there will be one component constant what is that is strike-slip component.

Another component may be of extensional component or it is a compressional component. So, if these two different components they are acting at different place independently that is called strike-slip partitioning, but it may possible at the same place these two components they are working together. So, that case it is not called this strike-slip partitioning. So, strike-slip partitioning it is only possible when these two components they are acting at different place at different time. For example, if you see here boundaries of obliquely converging or diverging blocks and plates that simultaneous motion on separate strike-slip and contractional or extensional structure may occurs because we have already decided this is the oblique-slip system.

So, oblique-slip system means there will be a strike-slip component and there will be compressional or that is extensional component. So, the strike-slip fault accommodate the component of oblique convergence or divergence that parallel to the plate boundary and this contractional or extensional structure accommodate the component oriented orthogonal to the plate boundary because if it is a oblique slip system one component is your strike-slip component another component is perpendicular to that. So, that's why this is oblique slip system. So, that will be either compressional or extensional that depends upon the geometry depending upon this stress. So, in which direction their opposite blocks are moving.

So, by enlarge one will be the strike-slip component another component will be orthogonal to that. So, the orthogonal may be compressional or may be extensional. However, where the strike-slip and dip-slip motions occur in different places and on separate structure are called strike-slip partition. So, as we have discussed this two components one is strike-slip component another is dip-slip components. If they are occurring at different places and on separate structures so, that is called the strike-slip partitioning.

So, one structure that will completely show a strike-slip motion another structure would complete so, either it is compressional or it is extensional system. So, that's why it will be called the strike-slip that means, the strike-slip component is totally partitioned from the dip-slip component. So, that's why it is called strike-slip partitioning. Both strike-slip and dip-slip components of this deformation may occur either on the same structure or both components may be distributed more or less uniformly across the zone. Based on the relative contribution of the strike-slip and dip-slip deformation the system may be classified into strike-slip dominated and thrust dominated system.

So, strike-slip dominated or thrust or normal fault dominated system. So, if this dominant component is strike-slip we can say it is a strike-slip component it is strike-slip dominated system and if it is a compressional system or thrust dominated it is a compressional dominated system. It is a normal fault dominated it is extensional-dominated system. So, either it is occurring separately or it is occurring together. If it is together occurring then we can say we can classify into 3 different components but if it is occurring separately we can say it is strike-slip partitioned.

So, this block diagram it says how this strike-slip partitioned is there how this positive and negative flower structure are there, where the push-ups is developed where this pull-apart basins are developed so like that. And the southern segment of the Alpine fault illustrates the strike-slip partitioned style of transmission. So, strike-slip partitioned means here strike-slip components totally different and different structures show only strike-slip component. So, here in number 1 if you see it is 1 million year when a series of pull-apart basins formed between the extensional step-overs. And presently when a linked among this fault have cut through this Dagg basin forming the Dagg ridge.

So, the schematic block diagram showing the 3 dimensional geometry of the adjacent releasing and restraining bend. So, all about your strike-slip component and strike-slip in the ocean system, strike-slip in the continental system, the strike-slip margin, the pull-apart basins, this ridges, push-up ridges and releasing bend and restraining bend. So, this system is complete which is remaining to this part that is this block diagram which is representing all total about this continental margin which is of strike-slip origin. So, thank you very much, we will meet in the next class.