

# ***CYCLE OF EROSION PROPOUNDED BY DAVIS AND PENK COMPUTERATIVE STUDY***

*By*

*Dr. Raad – Rahim Hamood.*

*Collage of education Geography department*

*Diala University – Diala .*

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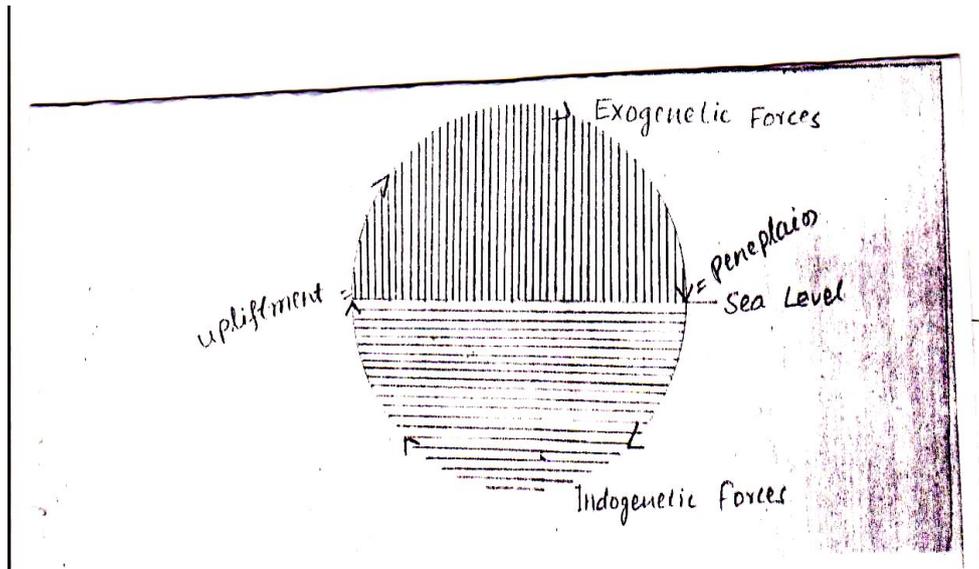
## **Cycle of ERSION : PROPOUNDED BY DAVIS AND PENK**

### **Introduction :**

Broadly speaking Geomorphology is the study of land forms which is a composite result of different exogenetic activities operated on that land surface or on that region . But exogenetic activities try their best to make a balance with that of endogenetic and their ultimate level of balance is the sea level below which that can not perform their respective work . so the balance between these two activities in a cyclic process is known as the cycle of erosion . Thus it has two part and taking together is the cycle . therefore . these two part has quite distinctive character , and one without the other has no significance in the creation of development of land forms , on which geomorphology is mainly based.

Complication of one cycle means the lowering of relative relief to the sea level , so it can be seen in one circle also.

The half of the above circle is showing the exogenetic forces operating.



On area to which different exogenetic agents are operating and bringing the elevated land to the sea level and this is the cycle of erosion.

It is important , therefore , to know what the exogenetic forces are.

Exogenetic forces are those forces which are operating on the lithospheric surface of the earth and trying its best to eliminate the differences made by the endogenic forces and made the surface at or near to the sea level , Exogenetic forces are also called denudation and denudation can be into two broad categories – weathering and erosion.

Weathering is that process which makes the bedrock either weak , fragmented or decomposed just near the earth's surface or to a depth of a few metres , So the fragmentation , decomposition or weakening of rocks make erosion easier but not a part of erosion . There can be weathering without erosion and erosion without weathering . According to Thornbun , " It is true that weathering is a preparatory and make erosion easier , but it is not prerequisite to , nor necessarily followed by erosion.

There are two main type of weathering physical and chemical . Both are affected by rock structure , climate , topography and vegetation , physical weathering occurs due to differences in the expansion of different minerals with different rate and chemical weathering take place due to chemical reactions with water ( and some gasses with water ) on the rock and make the rock even soluble.

In another words it can be said that repeated thermal expansion and contraction as a result of alternate heating and cooling results in the weathering of rock . Creation of joints and fractures and enlarging of the existing ones and finally to the disintegration of rocks and it is termed as mass exfoliation . In the rocks containing minerals which expand unequally there is granular exfoliation . In the same way chemical weathering takes place through different processes like – oxidation , hydration , carbonation , solution . So there are two end product of chemical decomposition and disintegration – residual such as clay and soluble such as calcium bicarbonate which can be removed in solution.

**Erosion:-**

Erosion is that process in which various erosive agents ( running water , wind , glacier , sea waves and underground water obtain and remove rock debris from the earth's crust and transport them for long distance . In another way it can be said that erosion a sum total of gnawing , abrasion and transportation . Agents of erosion are those which participate in the erosional works and mainly they are – Running water , underground water . Ocean currents , wind , glacier , periglacial etc.

Cycle of Erosion – At first William Morris Davis advanced the idea of " geomorphic cycle of erosion " in 1899.

His major objective was to describe and explain the distinctive characteristics possessed by landforms . he described that all landscapes have definite life history after its emergence. In this way through different stages and after a long time the elevated land mass becomes featureless and flat plain known as peneplain is called geographic cycle according to W. M. Davis. So he gives the definition of geographical cycle as -----

" The Geographic cycle is the period of time during which an uplifted landmass undergoes its transformation by the process of land sculpture ending in low featureless plain " – W. M. Davis.

Philip G. Worcester has also accepted the geographic cycle but he called it as the " cycle of erosion " . According to him –

" The cycle of erosion is the time required for streams to reduce newly formed landmass to base level " – p. G. Worcester.

The main agent of erosion at the present time ( in glaciation period i. c. and glaciers were there or it is now found on mountain top and higher latitude ) is water or river and a large percentage of area of the earth surface is eroded by this process . So due to its prominancy this erosional cycle is known as " normal cycle of erosion " .

According to woreester – " Geomorphic cycle is the topography ( not the erosional cycle ) developed during the various stages of the cycle of erosion " .

Davis has described the landscape as the function of structure , process and stage . This means that in a landscape all these three play dominant role. By structure meant that the nature of the rocks whether it is hard , soft , pervious, In the soft and pervious rocks cycle is completed in very short period than that no the hard rocks. Process determines that type of erosion would come on the surface and what type of landform would be under in a initial surface . Stage denotes that whether the land mass under going its transformation is in the young stage or in the old stage . Landscapes vary in the different stages , thus the landscape . is called the commulative result of structure process and stage.

Davis assumes that each landscape has definite life history . As soon as a landmass cmerged , ersional agents starts their works on it and finally take it to ultimate featureless surface . Newly uplifted landmass has been called initial surface upon which erosion starts.

For the purposes of demonstrating his cycle conecept in the most simple and persuasive away , Davis imagined as an initial form a mass of land up lifed from beneath the sea by earth movements.

### **The Stage of Younth**

Davis assumed that the up lift the land took place very rapidly , so that the processes of denudation were able to act almost from the start on what was in effect , a stable mass.

If the elimate were suffieiently rainy , as would normally be the case in humid temperate lands , a system of rivers would quickly develop on the emerged land surface , This would comparise a number of consequent streams whose directions of flow and velocities ( and thus erosional capabilities ) would be determined by the gradients of the initial surface . From the stage of infancy.

These streams would cut rapidly downwards , and would in due course from deep valleys . on these stops , weathering and slumping

would operate , but at quite a slow rate compared with the speed of river in erosion . for a long period the valley Eros profiles would be approx . mutely v. shaped except in areas of complex geological structure where stepped profiles would be developed.

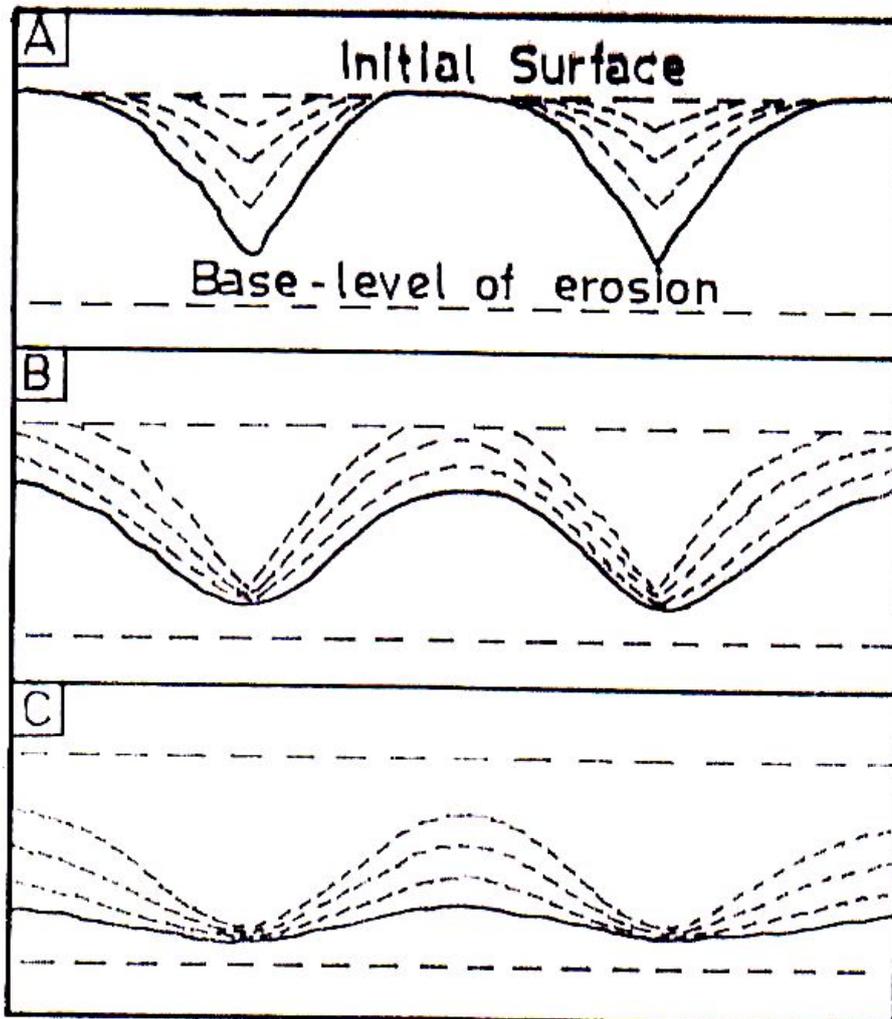
Throughout this stage , parts of the initial land – surface would be preserved on the watershed between the consequent streams, In infancy the extent of this initial surface would be considerable but would be gradually diminished later in the youthful stage as the valley side slopes experienced retreat and as tributary streams began to extend their valleys in to the interfluve areas by headword erosion.

### **The stage of Maturity:**

By the onset of this stage the deepening of the v- shaped valleys characteristic of youth would have been slowed down considerably . Through the formation of their valleys the various streams would throughout youth have lowered their channels nearer and nearer to what Davis termed " the base – level of erosion " ( which is normally the level of sea into which the eventually flow , and below which can not erode . In the process the Congitudinal gradients of the streams would have become ever more gentle , stream velocities would have been reduced , and the streams would possess less and less energy to use in moving their loads and attacking their beds, In fact , Davis suggested that , early in the stage of maturity , streams would attain a condition of grade of equilibrium , in which the entire energy of the stream is consumed in the movement of water and its load.

The gentle meanders of the youthful streams responsible for the inter – locking spur supposedly typical of youthful valleys , would become wider and more pronounced , and at many points the valley – side slopes would be underereut and driven back , By the end of the mature stage , slope angles in general would have been considerably reduced by the process of divide wasting and smoothly curving slope profiles with no major breaks , would

## DAVICIAN CYCLE OF EROSION



- A. YOUTH
- B. MATURITY
- C. OLD AGE

Dominant the landscape, An important result of divide wasting during maturity would be the reduction of relief, or in other words a decrease in the vertical height separating interfluvial summits and valley floors.

**The stage of old Age :**

By this stage the processes of landscape evolution would have become extremely slow in operation . This running down of the cycle would have resulted from the gradual reduction of river gradients and an associated decline of stream energy and the continued lowering in angle of valley – side slope so that creep and wash would become less and less active and mantle of slope detritus , impending mechanical weathering , would be extensive By comparison with youth and maturity the stage of old age would there fore be extremely protracted . River would continue to broaden their valleys by meandering so producing near – level valley floors over which during times of flooding alluvium would be deposited to give broad flood plains. By the end of old stage the relief would assume the form of a very gentle undulation plain , termed , by Davis a " peneplain " standing only a little above the base level of erosion . Above the peneplain a few isolated hills , as yet unconsummated by divide wasting , would remain . Such residuals were referred to by Davis as " monadnocks " .

**Evaluation**

Since the time of Davis , some geomorphologists have agreed that the peneplain should be regarded as a purely theoretical landforms , on the ground that the conditions of stable base level needed for the completion of a full cycle of erosion can not have persisted for a sufficiently long period of time . There is certainly much evidence to show that gentle earth – movements , involving both elevation and depression , are taking place today , and during the organic periods of the past crustal instability must have been greater .

Another argument is that , when a landmass is under – going erosion , it will tend to experience continuous uplift , simple because the unloading will initiate compensatory ISO – static movements , As a result rivers will always be incising their valleys , and attainment of the peneplain stage will be postponed indefinitely , It is true that in an area perfectly preserved surfaces of peneplanation do not exist at or near present sea level.

**Interruptions to the cycle of Erosion :**

Based on the concept of geomorphology " complexity of geomorphic evolution is more common than simplicity " , it can be said that multicyclic evolution of landscapes is more common than the

monocyclic development . Mature or old – age topography is likely to have superimposed upon it youth – full features as a result of the interruptions of cycle ( like climatic change and sea level fluctuations and rejuvenation )

Rejuvenation – Dynamic rejuvenation may be caused by tectonic uplift of a landmass with accompanying tilting and warping . Such movements may be rather localized and associated with neighboring organic movements , or they may be , as thought by some , would wide in nature . Localized downtilting , warping or faulting of a drainage basin will result in a streams which now have transporting power in excess of that required for transport of their loads.

### **Changes in sea level :**

This results from causes that produce world wide lowering or rising of sea level rather than localized . Eustatic change is change of sea level resulting from variation in capacity of the ocean basins , where as glacio – eustatism refers to changes in sea level produced by withdrawal or return of water to the oceans , accompanying the accumulation or melting of successive ice sheets . Eustatic lowering of sea level will cause rejuvenation of a stream at its mouth . Regarding of a stream toward the new base level will progress upvalley.

The result may be an interrupted profile with the point of intersection of the old and new base levels being marked by a knick point , which proceeds upstream as the new base is extended headward . Knick point can be shown from the Fig.

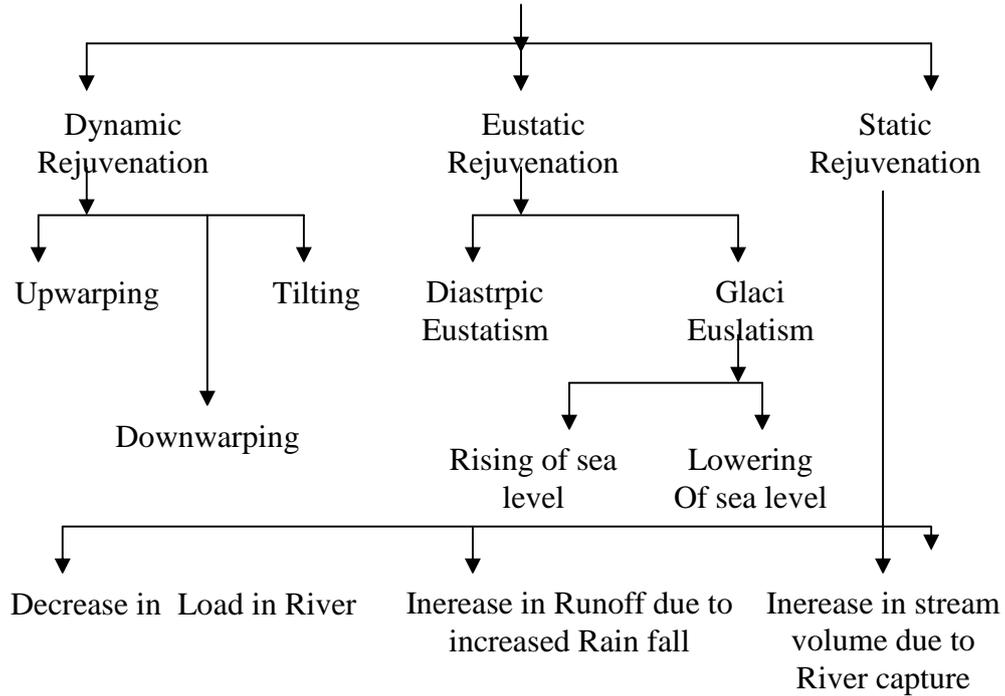
Knick point can also be represented by longitudinal profile of river as it is shown below taking as a hypothetical example:

Stream may exhibit signs of renewed youth from changes , which involve neither uplift of the land nor eustatic lowering of sea level . This has been called static rejuvenation.

Three changes may produce static rejuvenation . They are decrease in load , increase in run off because of increased rainfall and increase in stream volume through acquisition of new drainage by stream diversion or derangement . All these three causes produce the unbalance in the normal erosional activities for the time being , that can also be called the renewal of the cycle .

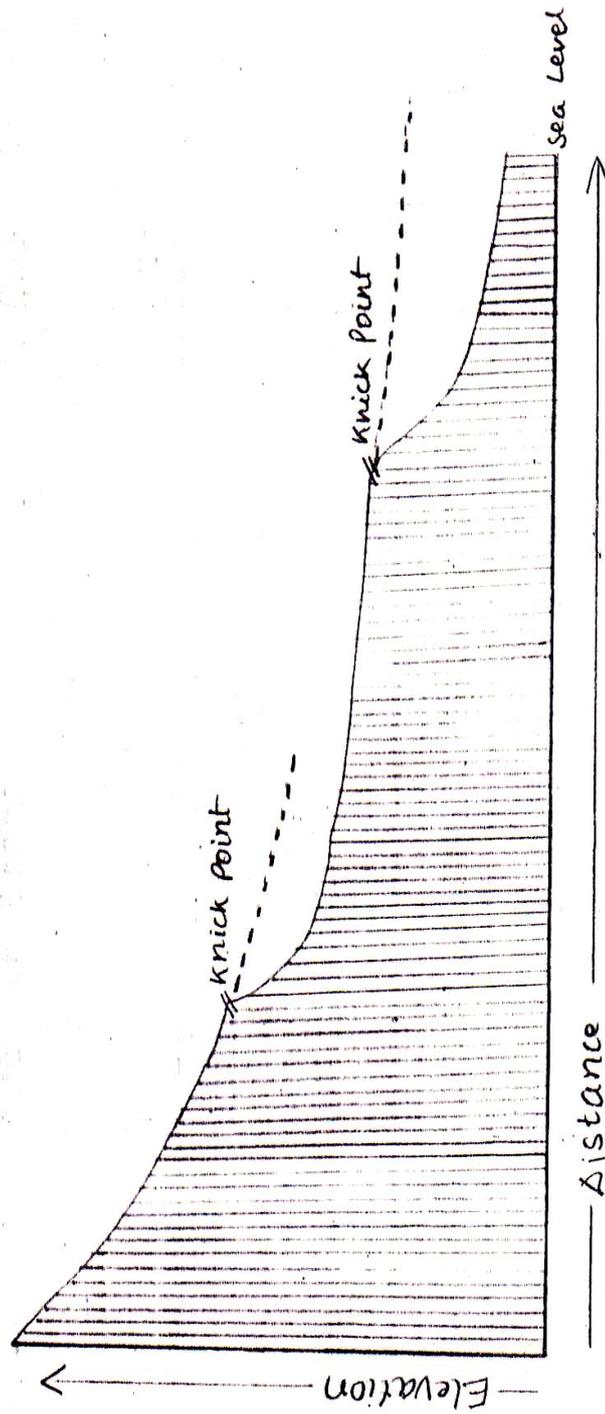
In short all these causes and ways of interruptions to the cycle of erosion can be shown at a place in one schematic diagram .

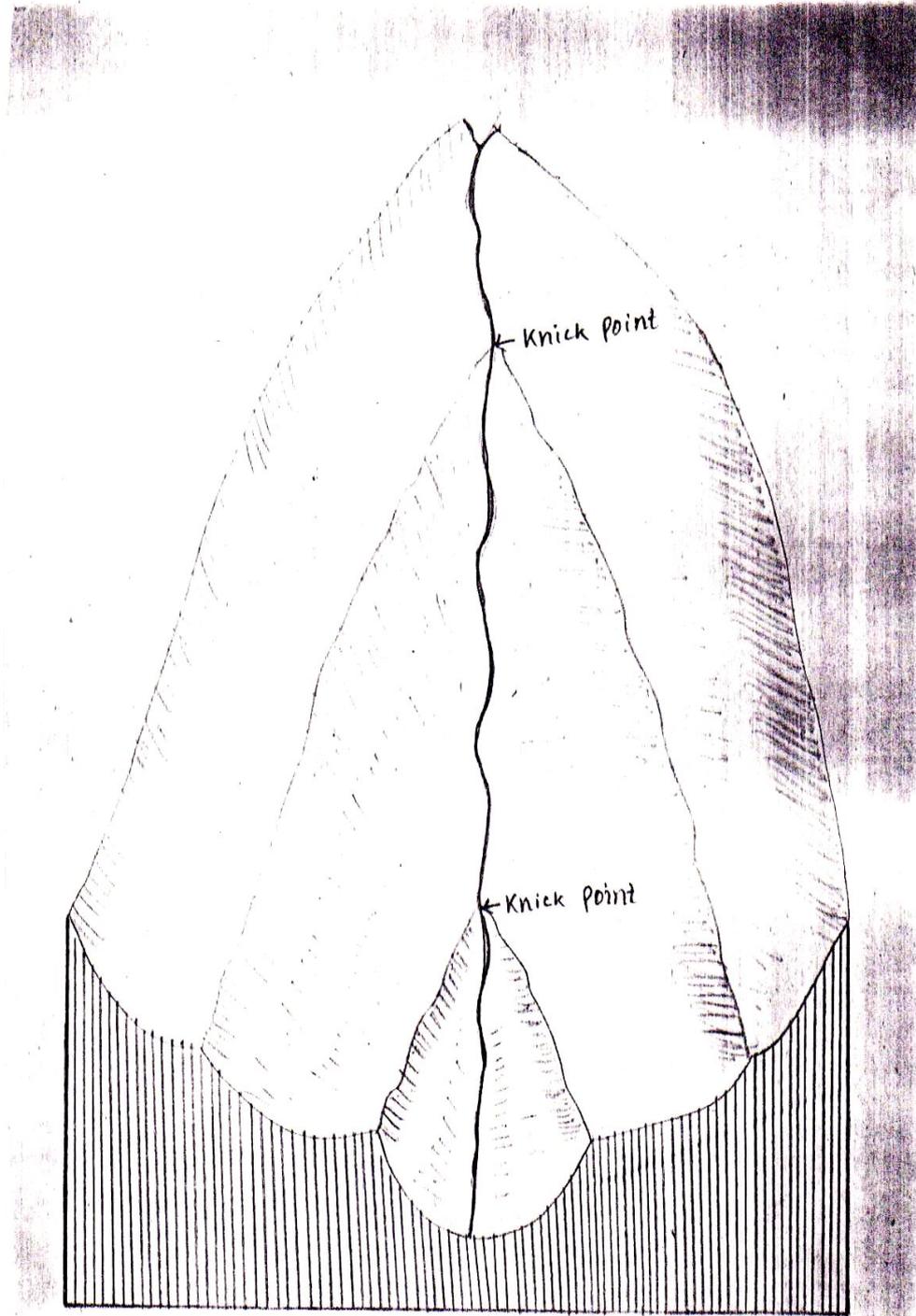
**Causes of Rejuvenation**



Longitudinal Profile Showing

Knick Points





Block Diagram Showing Knick points

It is quite true that river or fluvial erosion is more predominant but it does not mean that the cycle of erosion is applicable only in the fluvial cases . Yes , it is also applicable to the cycle of glacial erosion , the cycle of pediplanation and arid , the cycle of karst erosion.

### **CONCEPT OF DAVIS ON THE CYCLE OF EROSION**

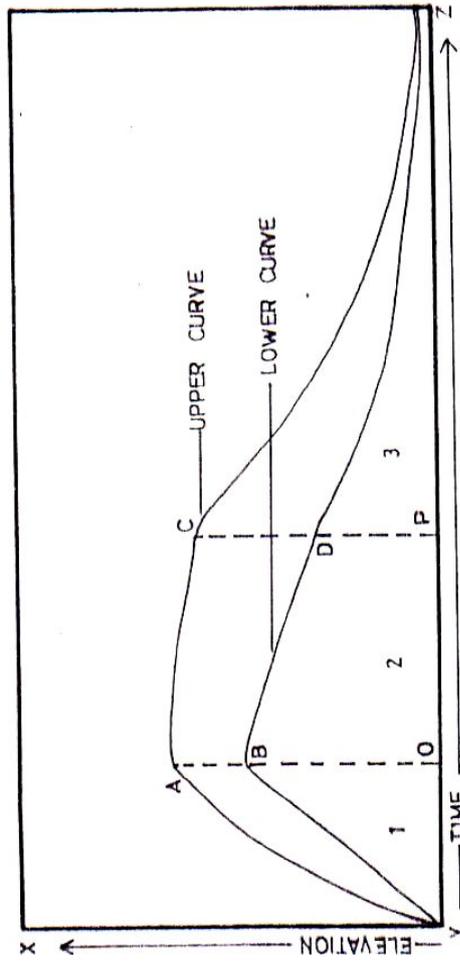
First of all , W. M. Davis pointed out that the development of landforms takes place through mainly three stage youth , maturity and old stage of river or the geomorphic cycle . Although some geomorphologists criticize him on this terminology of stage also, but after that it has great importance in geomorphology at this time too . In this way, landscape can be explained on the basis of the structure, process and stage. If so many landmass having same structure and some process with same intensity then all those landforms evolved on all those landmasses will be the same in terms of time factor.

#### **Upliftment and Erosion:**

Davis starts his geomorphic cycle with the uplift of land mass above the sea level but according to him this will be very small period because this Upliftment takes place rapidly so he assumes that there will not be any erosion in this case and erosion will occur only after the completion of the Upliftment . It is remarkable that Davis does not accept the simultaneous uplift and erosion.

In this graph time is shown on YZ axis and elevation on the XY axis , This graph also shows three segments each is a stage but in the first initial stage only Upliftment takes place . There is no erosional work in this period . So Davis has not included this stage to the stage of his cycle because his cycle starts from already elevated landmass . He has again divided last two stages into three stages of the cycle like youth , Maturity and old.

GRAPH OF DAVICIAN CYCLE



### **First stage :**

In this stage only Upliftment takes place and it is represent by Y to A . Through there is no erosion , the elevation and relief both are increasing , Now AB is the initial relief , which is the difference between upper curve and lower curve of a landmass . In another words relief is the difference between the highest and the lowest points of a landmass.

Thus initial relief

Upper curve – Lower curve = AB

i.e. , OA – OB = AB = relative relief.

### **Second stage :**

After OA , increase in elevation finished and erosion starts . in this ease there is no erosion or marginal erosion in the upper curve and more erosion on the lower curve.

On the lower curve , there is down cutting of the valley . So again the relief is increasing very rapidly . It is quite clear from the BD that there is more erosion on it than that of A. C. therefore . Ultimate maximum relief is represented after or just before going to end this stage .

### **Third stage :**

This stage is longer than the two ( first & second ) . In this stage maturity and old stage of cycle is included . In this beginning of this stage , the erosion is started on the upper curve also , thus the relief began to decrease continuously . So lateral erosion is more predominant than the vertical cutting . Thus , the maturity stage of cycle , And again after that lateral erosional intensified and both the curve come very close to one another and that gets the base level of erosion and thus erosions ends and this stage called the old stage . And now this is the completion of erosional cycle . This is the featureless landmass and he called it as the peneplain . Some resistant rocks can also be seen on that peneplain and to that he has called " monadnock " .

## **CONCEPT OF PENK ON THE CYCLE OF EROSION**

Through Penk has accepted the concept of the cycle of erosion but not like the concept given by Davis . Penk was the main critic of the Davisian cycle . Penk has also told wrong the concept of structure , process and stage in the penenplation of any landmass and he said that landforms are the result of phase , rate of uplift and degradation . That means how much upliftment as taken place , how much the rate of erosion is . Penk has given some different terminology at the place of Davis different stages , He has also accepted three but that are not showing the time factor but the rate of upliftment.

## **UPLIFTMENT AND EROSION :**

Penk believes that upliftment takes place through different rate He says that erosional activities and their agents will not wait for the final upliftment . As soon as any landmass comes above the sea level , the agents of erosion start their work and both these incident takes place together , but after some time upliftment will finish and degradation will continue until the land mass come to the ultimate base level or near to that when degradation is not possible.

Penk says that from beginning to end . the rate of upliftment is not the same . In the beginning it is quick , then it becomes normal and at last with decreasing rate . So to express these three rate of upliftment penk has three German terminology.

Aufsteitgende entwicklung :- This is the first stage of upliftment in ahich within a short period the rate of upliftment becomes very high .

Abstsigende cntwicklung :- in this stage it becomes very slow and in decreasing order Gleichforige cntwiekclung this is the misddle one stage between the above two.

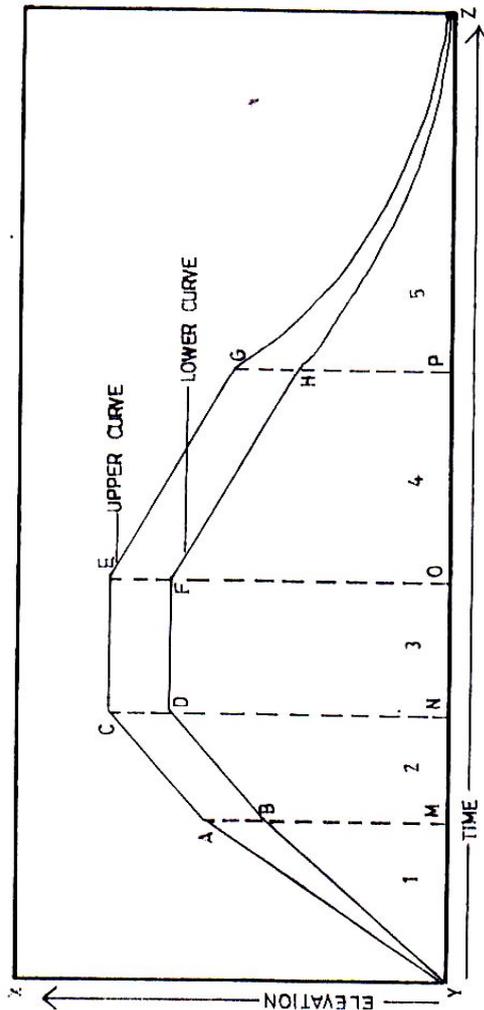
In this graph , it is quite clear that are two curves upper and lower.

Here upper curves represents absolute height and that of lower curve river valley . AB, CD EF and GH show the relief of different stages . He has divided the whole process into five categories.

First case in this case the degradation with increase in the height of landmass above the sea level . Upper curve is rising more than the lower curved which means the rate of upliftment is more then the rate degradation and this is why the relief is increasing Though the valley is being croded but interfluve summits or divided summits are not affected by this degradation Secod case in this quite clear from the graph – as – upper curve AC and lower curve BD.

Third case – in this case neither relief is increasing or decreasing nor erosional curve show increase or decrease . So both has same intensity that means all the new rise is cut down by the degradational agents and thus they are Parallel but constant it is shown on the graph by upper curve CE and lower curve DF .

GRAPH OF PENKIAN CYCLE



Fourth case – After the third case the uplift in the landmass is finished and now in this case down cutting and side cutting is prominent . So due to this reason both curve show the same rate of degradation in terms of absolute height and absolute valley bottom . So both curves show parallel on going trend . It is shown in the graph by EG ( upper curve ) and FH ( lower curve ) .

Fifth case – in this ease , the down – cutting decreased and the lateral cutting is still in operation which results the lowering of upper curve and rapidly than the lower curve and thus both curves come closer to one another which means again there is no relief left of that uplifted landmass and this called peneplain with a small elevation differential known as monadic . This is also called featureless low land reached at the ultimate base level.

**In short it can be tabulated as**

Case	Upliftment	Absolute height	Relative relief
First	Active	Increases	Increases
Second	Active	Increase	Constant
Third	Active	Constant	Constant
Fourth	finished	decreases	Constant
Fifth	finished	decreases	decreases
		Rapidly	

Comparative study of the cycle of erosion propounded by Davis and Benk.

<b>Davis cycle</b>	<b>Penk's cycle</b>
1. upliftment finished before Degradation starts.	1. upliftment and degradation strats together as soon as the landmass comes above the sea level.
2. The period of upliftment is small.	2. The period of upliftment May long or small or intermediately
3. The rate of uplift is very rapid.	3. different rate some times it is pride averge or slow also.
4. Landform is the result of structure , process and stage.	4. Landform is the result of the rate of uplift , rate of degradation and there lation ship in between these tow.
5. the start and end of the cycle is associated with three stages youth , mature and old.	5. He has not taken the stage into account but says three conditions of upliftment Aufsteigendo ( inereasing ) and geichformic (constant) Andabsteigende ( decreasing).
6. daives has not given more importance to dlope.	6. penk has more important Because it accelerates the rate of erosion and differentiate the landform.
7. There five cases , In first case relief inereases , and in second , third , and fourth it is constant and in the last fifth one it decreases .	7. In his case in the first two stage relief increases out of his three stage it decreases but never becomes constant .
8. Erosion does not exist in the first stage.	8. Erosion takes place in every stage and every cases .
9. He has assumed the last stage of cycle as the " peneplain "	9.He assumes the last stage as " Endrumpf "
10. His cycle over humid areas	10. His cycle over arid areas

Thus , this comparative study reveals this thing that there is great difference between these two concepts developed by Davis and penk. But this difference can be explained by the fact that both has different way of working and has different types of contacts when both were studying . Davis propounded his concept after studying the surfacial structure Of North America.

That is why , he gave more importance to structure and with that to process and stage . On the other hand , penk was influenced by the common informations of Alps . In reality , the main aim of penk is to study history of gromorphic units through present to past whereas Davis comes from past to present . This why penk's view is called " back ward looking concept " where as that of Davis is " forward looking concept " .

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