Based on the composition of ejected magma, volcanoes are classified into three well demarcated categories. These include :

Basic Cone

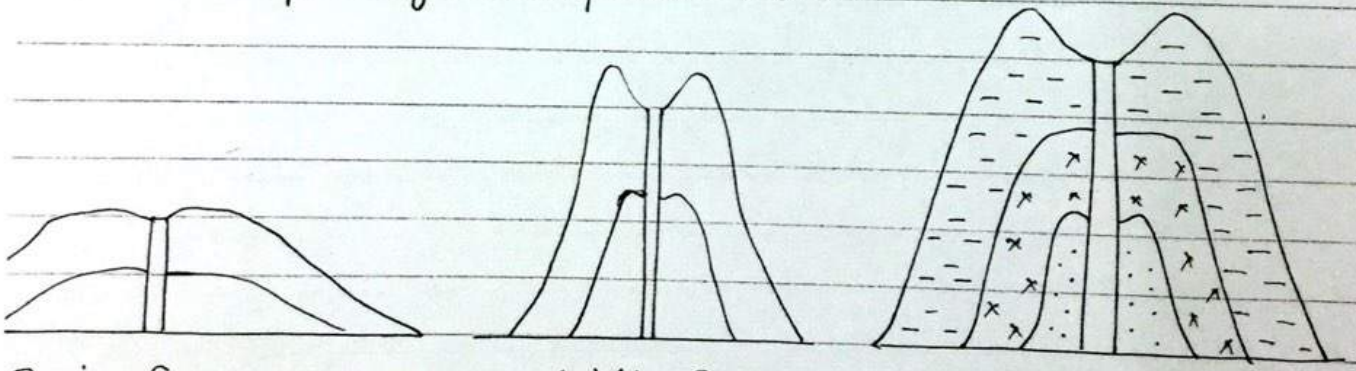
Acidic Cone

Composite Cone

BASIC CONE : It represents the volcano developed by mobile type of magma with broad base, gently sloping sides and shorter height. Mt. Mona Loa makes excellent example of such cones.

ACIDIC CONE : The acidic cones incorporate more viscous magma, have narrow base, steeply sloping sides and taller height. Mt. Vesuvius forms excellent example.

COMPOSITE CONE : As every central type of ejection correspond to well-developed stratas developing different episodes of ejection ; compositionally, each strata involves elementary difference making every vulcanic cone example of composite cone.



Basic Cone Acidic Cone Composite Cone

TYPES OF VOLCANIC CONES :

The Central type of activity also correlates to the development of distinctive 2nd order features. These includes :=

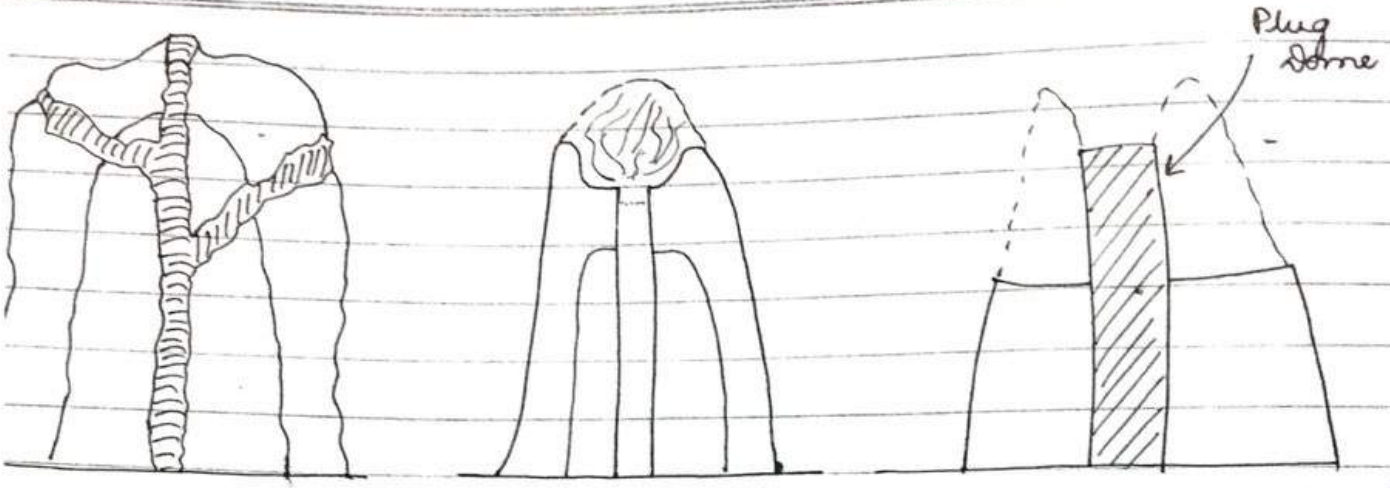
(i) Parasitic Cone
(ii). Cinder Cone
(iii) Caldera Dome
(iv) Plug Dome (special type of dyke*)

The parasitic cone develops when the pipe of the volcano have more than one vent which results in the development of more than one crater in the volcanic cone. Mt. Shasta (USA) and Mt. Fujishan (Japan) makes the examples.

The Cinder Cone in comparision represents that type of volcano cone which involves geometrically correct conical shape evolved due to deposition of pyroclasts In the crater Mt. Mayon (Phillippines) makes excellent example. The feature called Caldera is defined to be enlarged crater. This enlargement can be correlated to exploding of the existing cone or collapse of crater. Enlarged crater called caldera do incorporate possibilities of "exposed pipe" i.e. referred to be plug dome.

Both crater (of dormant volcano) and caldera can incorporate accumulation of rain water developing lakes. It is only with caldera lakes, however, that the presence of central islands is projected.

Prominent examples of crater lakes of the world includes L. Toba (Indonesia) , L. Taupo (New Zealand).



Parasitic Cone Cinder Caldera & Plug Dome

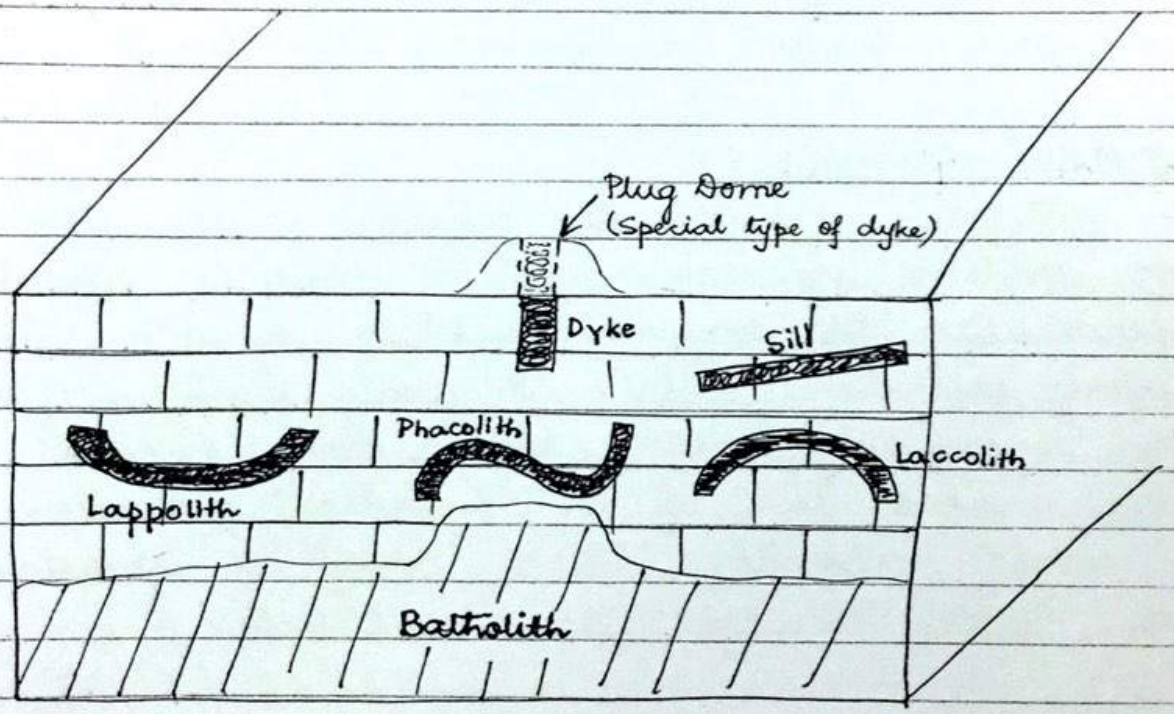
ntrusive Vulcanism : → Massive
→ Tabular → Concordant
→ Discordant

lovement of molten rock material towards the surface of the earth when makes it solidified within the existing lithospheric stratas, intrusive vulcanism is identified. Magma in its passage towards the surface partially melts the host rock and occupies the created location with variable shape and sizes. The intrusive vulcanic features therefore are classified in absolute accordance to their shape and size.

Based on size, massive plutons are distinguished from tubular plutons. The massive plutons are the gigantic size of magma deposits within the lithospheric stratas where demarcation of alignment of magma deposits is unlikely. Such huge masses are largely developed in most plutonic locations where the intruded magma is having the capacity of melting maximum of the host rocks. Being most plutonic, such type of deposits are largely not exposed on the surface of the Earth. Such massive plutons are called batholiths and smaller extensions are called stock.

Batholiths are always associated with xenoliths that are remains of host rock. The Dartmoor Range in Great Britain (U.K.) is believed to be the example of exposed batholith. The tabular plutons represent those magma intrusions which are not just smaller in size but are also well specified with alignment of magma deposits. This category is distinguished as concordant and discordant features.

Concordant : Horizontal layers
Discordant : Vertical layers
Acidic magma : Cools swiftly, forms irregular shapes.



a) Concordant Tabular : The concordant tabular features are horizontal or near horizontal i.e. in accordance to the alignment of original beddings of lithosphere Sill makes par excellent concordant feature. It

represents solidification of more mobile magma in horizontal sheets. Excellent exposed example of sill is PALISADE SILL along Appalachians near Hudson River. The variance of concordant features involving slight acidic magma includes laccolith, lappolith and phacolith. The laccolith are dome-shaped tabular magma deposits which makes one of the commonest concordant plutons. Most recognised example of exposed laccolith is GHAAP PLATEAU (South Africa). The lappolith are the saucer-shaped tabular magma deposits. They represent their exposed example as BUSH VELD (South Africa). Phacolith makes the wave-shaped concordant pluton significantly smaller in size.

Discordant Tabular :
This category includes the tabular plutons that have vertical or near vertical magma deposits perpendicular to original bedding of rock. This category includes DYKES. The only identified feature with a variant called plug-dome exposed dykes makes few of the important mountain of the world including UKMES RANGE in Zimbabwe, and SUGAR LOAF MOUNTAINS in Brazil.

Vulcanic Landform features
(i) Lava Plateaus
(ii) Cones & related features
(iii) Intrusive Volcanoes

MOUNTAIN BUILDING WITH GEOSYNCLINE & THEORIES

Mountains are defined to be the most projected 2nd order relief features with conical profile, steep sloping sides, tall peaks and deep valleys. This feature, therefore, involves the combination of both endogenic upliftment and exogenic down-cutting. Geomorphologically, mountains are classified both on the basis of process of formation and time of formation. In the process of formation - fold mountains, block mountains and relict mountains are distinguished.

i) The relict mountains represent the category that are effectively eroded by exogenic forces. Relict mountains, therefore, corresponds to Ancient and old mountains classified on the basis of time of formation. The ancient mountains that are conical remains of ancient shields belongs to Azoic era. Old mountains representing paleozoic era includes Caledonian i.e. Devonian and Hercynian i.e. Permian categories of mountains. The Caledonian categories include Appalachians, Eurasian mountains, and Sierra De Mantiquera as major examples. On the other hand, the Hercynian category includes Great Dividing Range, Drakensberg as important examples.

ii) The young mountains belonging to Cenozoic era with their original heights represent to be fold or block categories and not relict.

* Relict ⇒ Not growing anymore
Getting levelled by levellers.
Azoic, Paleozoic

Cenozoic ⇒
Fold or Block

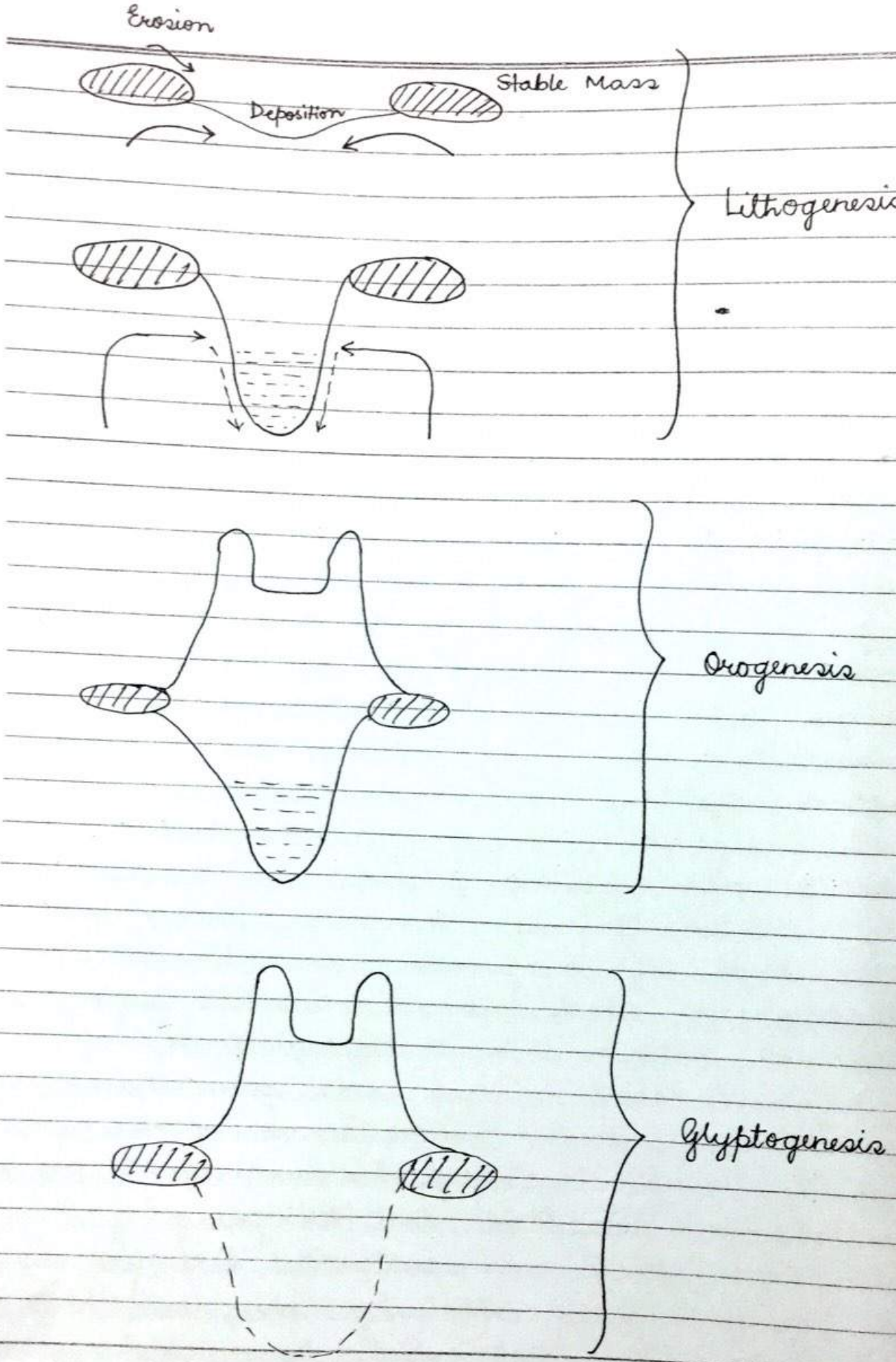
metamorphic rocks as quartzite, shale and slate. In comparision, the eugeosyncline relating to oceanic margins apart from involving sedimentary and metamorphic stratas also includes igneous i.e. vulcanic stratas.

The contribution made by Schuchert in the development of concept of geosyncline is classifying geosynclines on the basis of processes of sedimentation and orogenesis. He identified 2 types of geosynclines called monogeosyncline and polygeosyncline. The monogeosyncline correlates to single major episode of sedimentation followed on by single major episode of folding. Appalachians forms the excellent example of such geosynclines. In comparision, the polygeosyncline involves many episodes of sedimentation and many episodes of folding, resulting in parallel running mountain ranges. Himalayas make excellent example of polygeosyncline. Applying ~~to~~ this category of classification, geomorphologically almost all old fold mountains are referred to be representing monogeosyncline and almost all the young fold mountains are referred to be representing poly-geosyncline.

The established concept of geosyncline was applied for mountain building process by Kober. His mountain building approach incorporate 3 well-defined stages — Lithogenesis, Orogenesis and Epeirogenesis. His descriptive approach was made rationally-oriented by Arthur Swether Holmes who integrated

convective magma currents as the cause of deepening of geosyncline and generating compressional stress.

- The lithogenesis stage involving shallow and broad geosyncline bounded by stable masses on the either side is believed to be experiencing continuous sedimentation due to the erosion of the stable masses. By the end of the stage of lithogenesis, the geosyncline registers its transformation from broad shallow to significantly deep and narrow.
- Beginning of compressional stress sets in the beginning of the folding of these sediments i.e. the stage of orogenesis. It is in this stage that along with the development of parallel mountain ranges there is also the development of medial mass. These are comparatively less elevated regions depicting weaker compressional stress with increasing distance from the stable mass. All the inter-montane plains and plateaus are medial masses Eg. := Tibetan plateau, Hungarian plains etc.
- The stage of orogenesis concludes at Glyptogenesis which represent complete folding of sediments with or without closing down of geosyncline. Kober's analysis was given the scientific correction by Arthur Holmes, increasing the validity of the concept. Practically, however, this approach explains fold mountains, that too young fold mountains along mid-continental belt proving to be insufficient in explaining orogenesis. It is only plate tectonic theory that explains orogenesis in complete perspective.


Erosion
Stable Mass
Deposition
Lithogenesis
Orogenesis
Glyptogenesis

Map: Europe –
Dinaric Mountains
Hungarian Plains
Carpation Mts.

N. America –
Columbia
Colorado (intermontane)

Asia –
Kunlun Shan
Tibetan Plateau (Medial mass)
Himalayas

PLATE TECTONICS AND OROGENESIS:

(i) Tectonic theory recognises mountain building to be effective at plate boundary.
(ii) Dynamic locations of boundaries are applied to explain older mountains.
(iii) Explains young mountains in all its categories and location as :=
(a) Mountains at colliding boundary
(b) Mountains at destructive boundary
(c) Mountains at diverging boundary
(d) Mountains at transverse boundary.

A) Colliding boundary mountains as Himalayas depicts Miogeosyncline with no vulcanism.
B) Destructive boundary mountains are also fold like Western Cordilleras representing Eugeosyncline with active vulcanic cones. It can be divided as:
(i) Andean Type (Oceanic - Continent Convergence)
(ii) Mariana Type (Oceanic & Oceanic - continent convergence)
C) Diverging boundary mountains are block mountains

on continent crust as Mitumba, Muchinga along great African Rift Valley and includes extensive submarine ridges that are oceanic volcanic mountains as mid-Atlantic ridge.

) Transverse boundary mountains are again block mountains with stippage movement as Sierra Nevada and ~~Wastach~~/ Wasatch (Utah, USA).

EXOGENIC FORCES

Exogenic forces are defined to be the forces that originates on the surface of the Earth and induces effect on it. These are defined to be the levellers by the father of geomorphology, Davis. The exogenic forces includes :

(i) Weathering
(ii) Mass Wastage
(iii) Gradation

Weathering is defined to be "static / in-situ" disintegration or decomposition of the rocks. It is, when combined with mass wastage i.e. gravity transfer of the broken rock, acts as levellers. Compared to it, gradation is the continuous levelling process which involves three simultaneous activities called :

- Degradation (erosion)
- Transportation
- Agradation (deposition)

These are carried on by the agents of gradation which individually develops different topography and/or cycle in their role as levellers. These agents include :

(i) Running water (Fluvial topography / cycle)
(ii) Glacier (Glacial Cycle)
(iii) Wind (Eolian Cycle)
(iv) Sea Waves (Coastal Cycle)
(v) Underground water (Karst topography / cycle)

Among these 5 agents running water or fluvial action is recognised to be <u>universal</u> in its

nature as it is effective in all the geographical locations. This universal agent involves the categories of erosional capacity depending on the volume of water. It is in accordance that splash erosion, sheet erosion, gully erosion and stream erosion are distinguished. The splash erosion is carried on by individual rain drop with their falling force in the moistureless sandy surface of deserts. In such locations absence of vegetative barrier also facilitates development of flash floods following sudden torrential rain. Such flash flood water creates sheet erosion i.e washing away of entire top layer of sandy surface. More permanent fluvial erosion includes gully erosion carried on by streamlets that are smaller streams with more seasonal characteristics. The true fluvial action corresponds to stream erosion i.e. river erosion. In this category, fluctuations in the volume of water in the annual seasonal cycle regulates the erosional capacity i.e. that is called river regime. Prominently the river regime is classified into 3 categories :=

(i) Simple regime
(ii) Complex regime
(iii) Compound regime

Simple regime is represented to be water volume fluctuations with one high level followed on by low levels. Such type of regime is applied to the river systems which have same season of

glacial melt and precipitation combined with less dense network. R. Volga (Russia) and the lengthiest river of China, Chang Jiang, represents the example

Complex Regime:

The complex regime is developed when annual water volume fluctuations develop 2 maximas. This type of regime is typical to Mediterranean climate with winter concentrated rains as it is in lengthiest river in Europe, River Danube and it is also identified in equatorial climate where during equinoxes there is always rain maximas. R. Congo forms excellent example.

Compound Regime:

This regime incorporates lesser fluctuations in river regime as per the effectivity of dense drainage network. All the big river systems as Gangetic system, Mississippi - Missouri river system, Paraguay - Parana river system forms excellent examples.

Map: S. America: River Amazon (Complex)
R. Paraguay – R. Parana (South) (Argentina, Brazil)
Rio Deo Plata (mouth)

Africa: R. Nile (L. Victoria - Source)
Simple regime
R. Congo (Dem. Republic of Congo)

Asia: Chang Jiang (China)

Europe: Southern Germany → Black Sea (Danube River)
Mediterranean Climate

5 March 2014

LECTURE (13)

Long-profile of river :

Young	Mature	Old
Source		Destination / Mouth
Erosion	Transportation	Deposition

NORMAL CYCLE OF EROSION / DAVISIAN CONCEPT / FLUVIAL CYCLE OF EROSION

American geomorphologist William Morris Davis propounded normal cycle of erosion way back in 1889, to identify the nature of influence induced by universal leveller - running water or stream. He based his concept on the empirical studies carried on in different physiographic regions. He outlined that depending on the nature of prevailing climate, distinctive type of levellers will register their effectivity in the development of landscape. He emphasized that exogenic downcutting begins only after conclusion of endogenic upliftment. Moreover, the exogenic downcutting has well-defined stages of erosion and that end-product of erosional cycle is called, erosion surface, will be featureless lowland. To develop his concept, he utilised universal agent in the hypothetical location after the completion of the upliftment process. His entire concept is based on the fact that landscape is function of structure, process and stages, i.e.,

$$L = f(\text{structure}, \text{process}, \text{stage})$$

STRUCTURE :

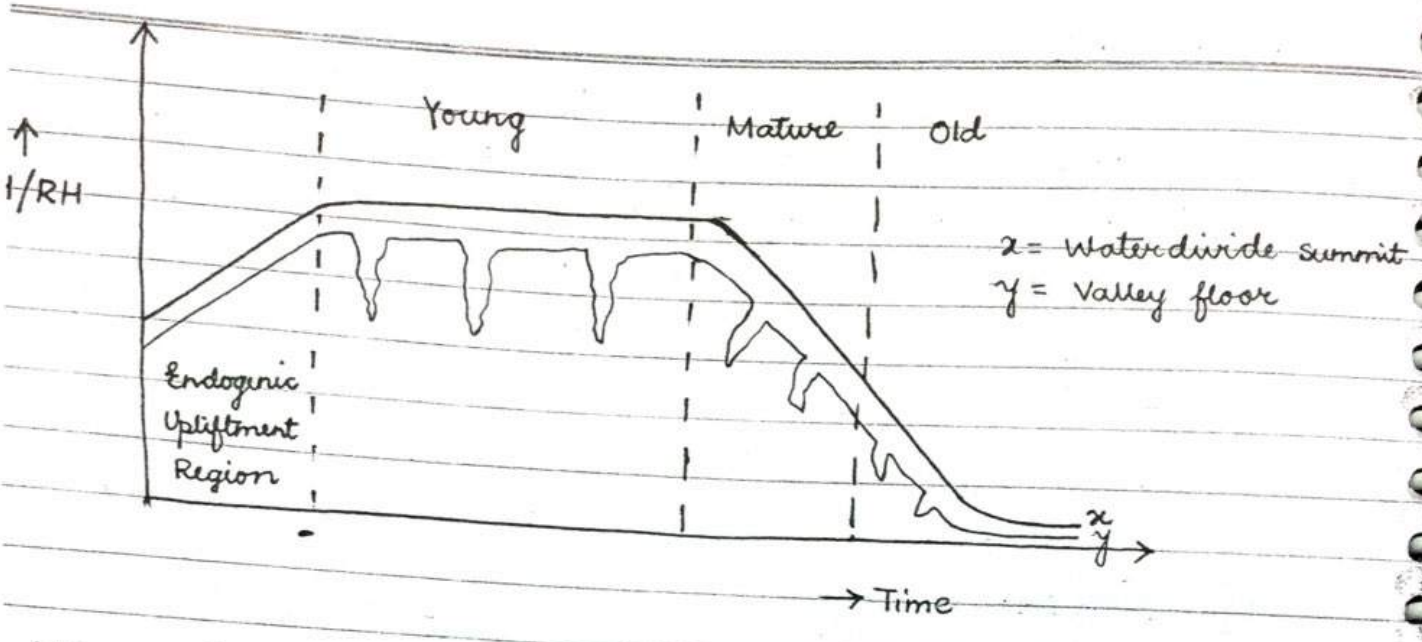
In the term structure, Davis emphasized on compositional constituents of the relief features. He emphasized that the relief features made up of less resistant construct will fast forward the cycle of erosion. However, if relief is comprised of resist material, it will delay the completion of cycle. In the expression structure, he also included minor structural elements like presence of or absence of joints.

According to Davis, it is variation in the structure of relief that the differential erosion generates bigger range of third order relief features.

PROCESS :

In the term process, he included both endogenic and exogenic processes and emphasized that endogenic processes are variability developers and exogenic processes are levellers. Elaborating exogenic category he identified that 5 different levellers reveal similarity in attempting to work to wipe off the generated variations. Moreover, they all are engaged in three-fold task : eroding, transporting and depositing and all of them increases relative height in order to decrease the absolute height. These agents, however, reveals variations in their effectivity in terms of different areas of functioning, different methods of functioning and development of different set of relief features. His entire concept, however, is built up in the analysis of stages.

STAGE :



Young stage : The young stage of the cycle of erosion begins with the end of endogenic upliftment. In this stage, developed active channels generate their well defined ungraded long-profiles moving from the source to their respective mouths. Each channel in this stage reveals 3 fold task : deepening, widening and deposition. In the reference of steeper gradient, this stage however marks prominence of valley deepening or vertical abrasion. It is therefore that the topographical features like V-or I-shaped valleys, rapids, cascades, waterfall and structural ~~beach~~ benches dominates the landscape. With the occasional cutting of the banks of the river in terms of the increased water volume, there is the gradual "shift" of the water divide summit. This shift may or may not relate to river water piracy. When the water-divide summit between the two ungraded channels is completely eroded, landscape enters mature stage. This transition is also referred to be the development of graded long profile among the

main channels. The 'swiftness' of erosion of water divide summit apart from being dependent on structure of the relief is also dependent on the factors like drainage density.

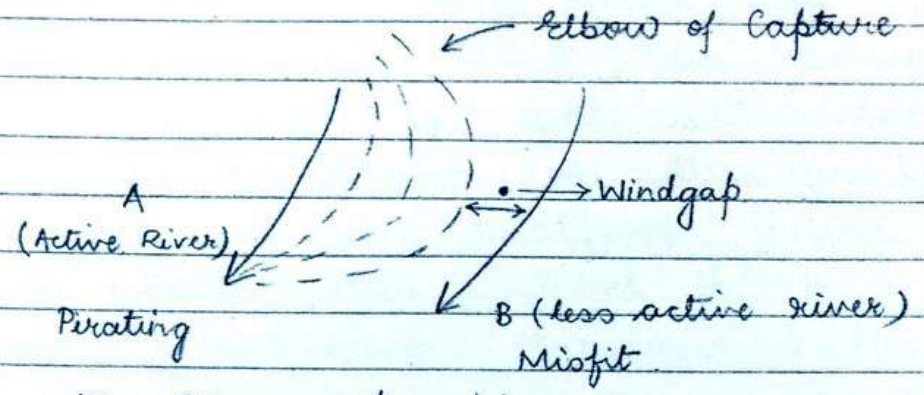


Fig. River water piracy

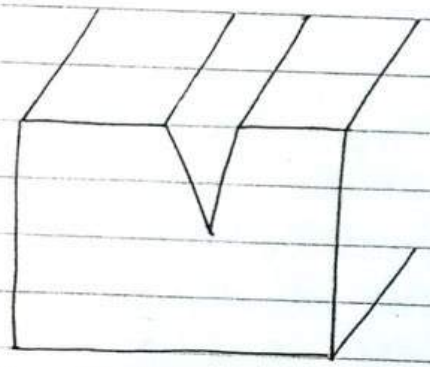
(ii) Mature Stage :=

The mature stage of normal cycle of erosion as begins with decrease in the absolute height and thus related gradient is prominently correlated to valley-widening activity. In this stage of landscape, dominating features thus includes flood plains with natural levees and bluffs along with wide meanders with river cliff and slip-off slope. This stage of cycle of erosion, however, marks continuation of valley deepening and deposition as well.

(iii) The Old Stage :=

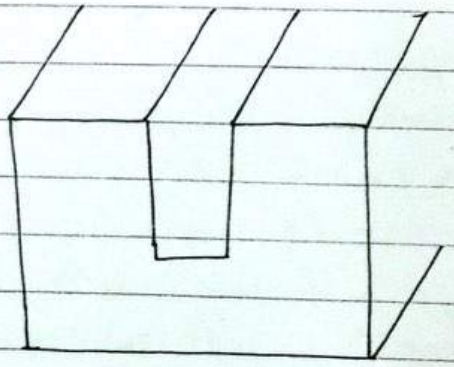
When the water divide summits ~~of~~ between the tributarie (small channels) gets eroded it generates graded long profile among the tributaries making the landscape enter the old stage. The delay in attainment of graded long profile by the tributaries

related to lesser volume of water. The beginning of ld stage, therefore, largely corresponds to near omplete termination absolute height which makes the ctive channels dominantly engaged in deposition. t is with this stage, therefore, that deltaic deposits are associated along with intense meanders with ox-bow lakes. This stage of cycle of erosion marks its completion with the development of featureless lowland called peneplains that are end-product of normal cycle of erosion, with dotting presence of "resistant thus remnant" monadnocks (isolated rock hill or mountain).



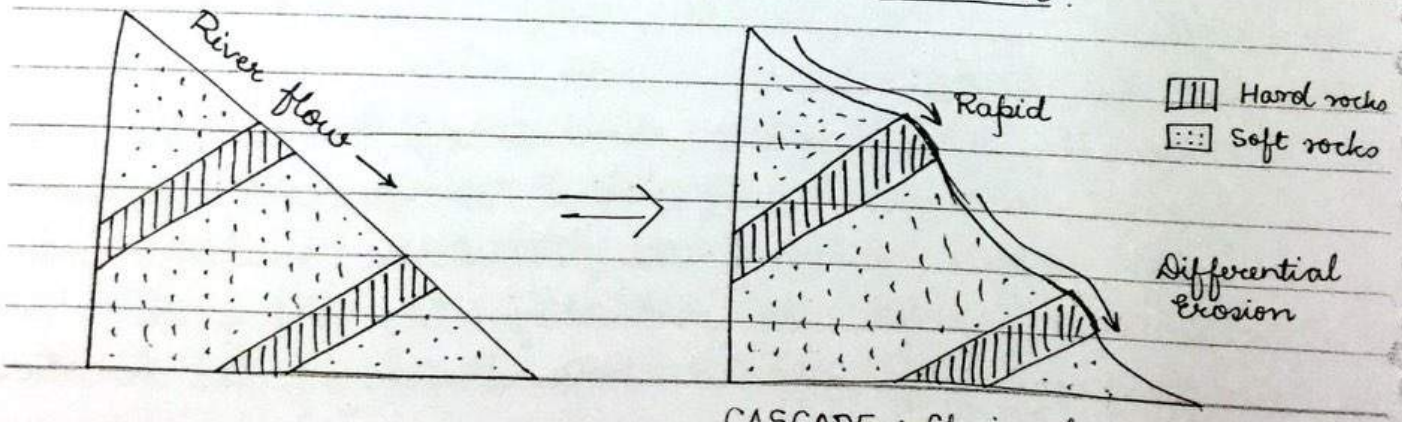
Differential erosion
+
More volm. of water

V-SHAPED VALLEY



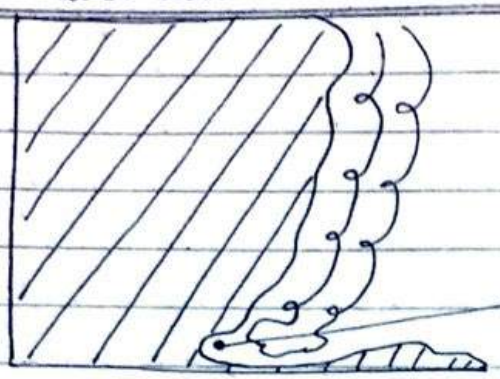
Homogeneous Structure
+
Lesser volume of water

I-SHAPED VALLEYS / GORGES / CANYONS



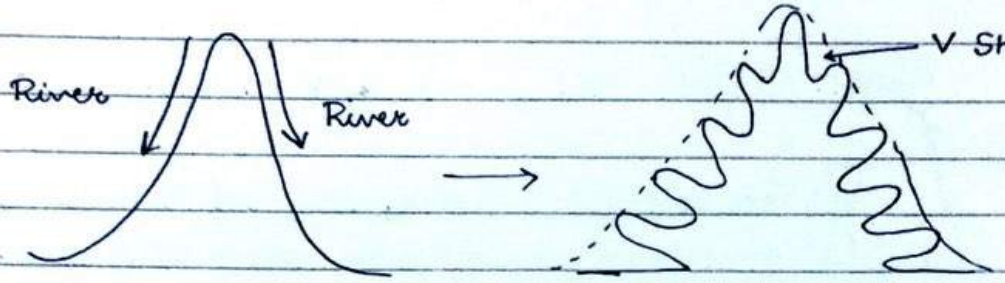
CASCADE : Chain of rapids

River Flow →



⇒ Waterfall
(enlarged rapid)

Plunge pool
(Abrasional hollow)



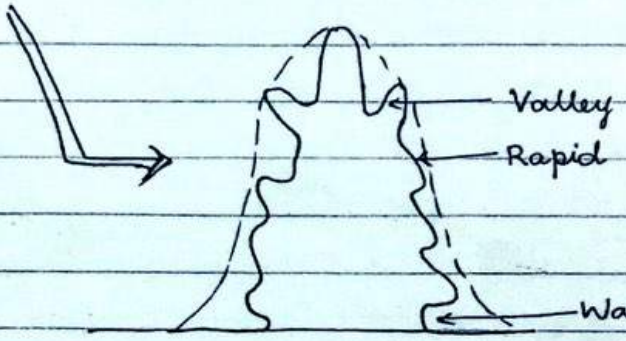
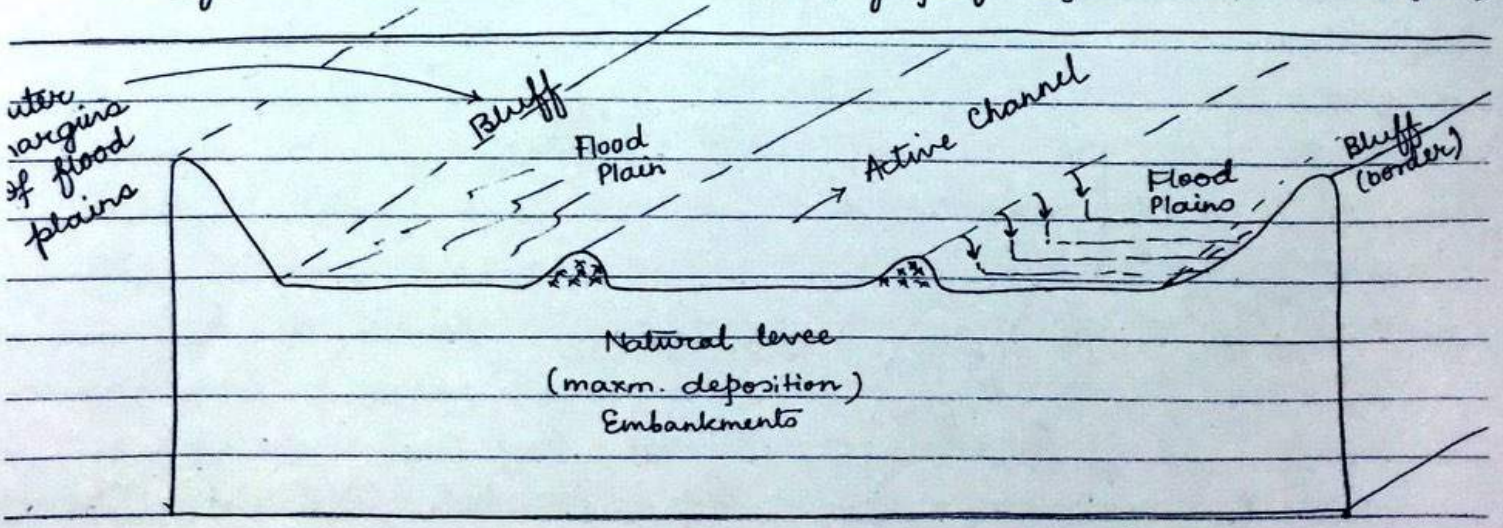
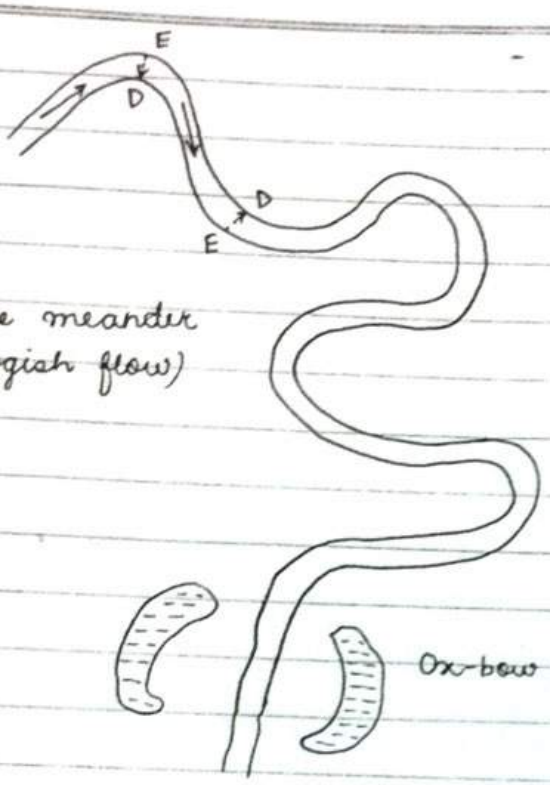


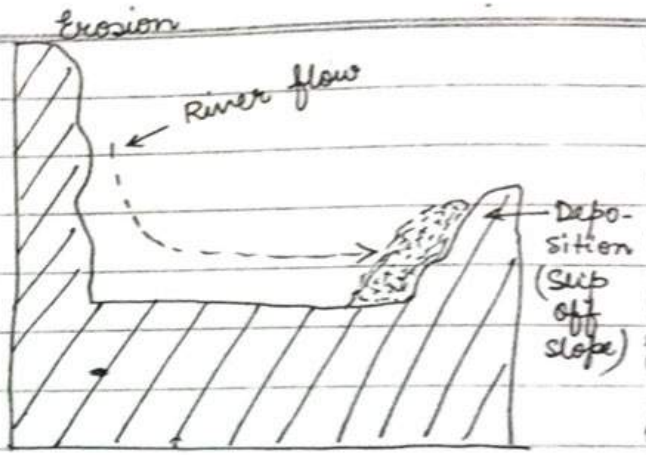
Figure: Structural Benches (Long profile of mountain course of river



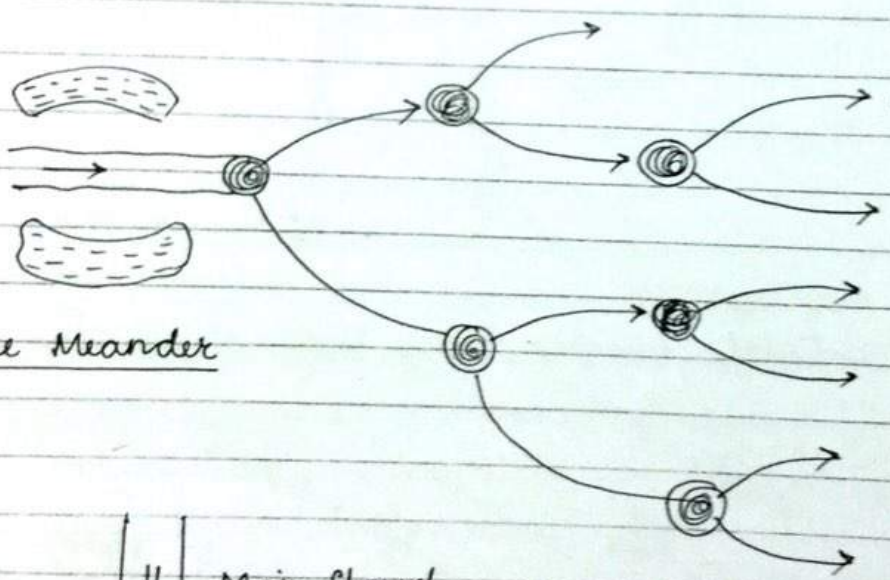
Mature Stage: Flood Plains & associated features



Wide meander
(Sluggish flow)



Ox-bow lake : Cut off loops of intense meander, formed during dry season, temporary.



Intense Meander

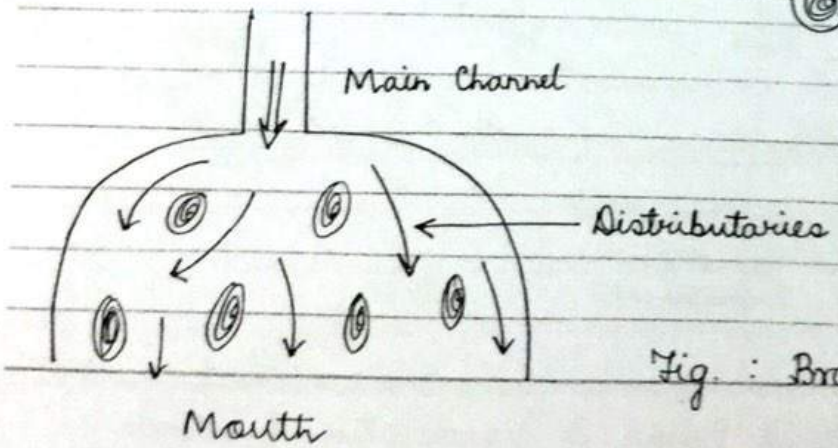


Fig. : Braided (Obstructed) Channel

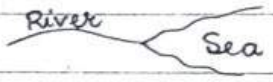
Types of Delta:

(i) Lobate / Arcuate – Triangular shape eg. R.Nile, R.Niger

(ii) CuSpate / Toothshaped – ⊔⊔⊔ eg. R.Padma, Jamuna

(iii) Digitate / Bird's foot –  eg. R.Mississippi – R.Missouri

(iv) Estuarine Delta –



eg. R. Amazon.

Date : 02/03/2014 LECTURE : (14)

Appraisal of Davisian Concept :=

Davisian Concept was originally published in 1889, oriented towards explaining the nature of functioning of exogenic forces. His approach continued to dominate geomorphological studies till the plate tectonic theory in 1960s. In between this timeframe, German geomorphologist Penck attempted strong criticism to Davisian ideology in terms of treating endogenic and exogenic forces to be following each other rather than being complimented However this scholar due to his untimely death could not produce the appropriate published idea. Recognised as the most mis-interpreted geomorphologist Penck could not create the desired counter balancing school. It was therefore that only in the light of plate tectonic theory that the approach was put to criticism. The tectonic theory clearly identifies that upliftment is diastrophism and for such long time downcutting cannot remain passive. As for example, Cenozoic orogenesis is yet not over. However, all the mountain of this era correlates to wide range of third order

reliefs making endogenic upliftment and exogenic downcutting being prevalent simultaneously. In the light of the theory it was also highlighted that the azoic constructs continues to project table-land characteristics i.e. with well recognised absolute height. This justifies that downcutting process is also long time-taking and for such long period, endogenic forces cannot remain positive. This theory therefore prominently criticised use of term CYCLE in the Davisian Concept. It is this criticism that made the approach of William Gilbert, called as the Approach of Dynamic Equilibrium come into line light. Gilbert was senior American scholar who propounded that the landscape is in dynamic equilibrium to the tendencies towards variability and tendencies towards uniformity i.e. the endogenic and exogenic forces compliment each other in development of relief features. Technically correct Gilbert approach, however, is utilised only towards the study of REJUVENATION and Davisian Concept due to its simplicity is taken as the prominent support system to the study of exogenic forces.

REJUVENATION / POLYCYCLIC LANDFORM / 2nd CYCLE OF EROSION :

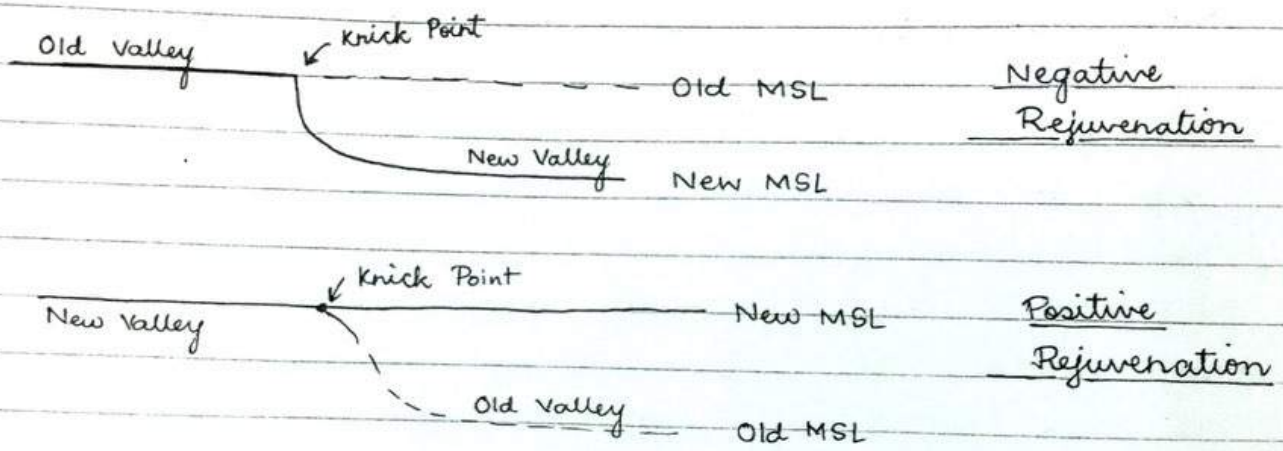
Rejuvenation is defined to be modifications in the work of levellers induced either by climatological agents or geomorphic agents. These modifications are boldly classified into :=

1) Positive rejuvenation
2) Negative rejuvenation

The positive rejuvenation represents those modifications which facilitates levelling. Such type of rejuvenation is commonly associated with the change in the mean sea level after the termination of ice-age. The Pleistocene ice age termination marked the change in the MSL of upto 200 m enundating the coastal areas and facilitating levelling tasks at regional to local levels. Positive rejuvenation can be correlated with subsidence of land and rise of sea-floor.

The negative rejuvenation in comparision generates polycyclic landforms or 2nd cycle of erosion. It is defined to be those modifications induced by climatic factors or geomorphic agents that interrupts levelling. In negative rejuvenation the expression of re-attainment of youth is thus practically applied. Important recognised examples of negative rejuvenation or polycyclic landform are valley in valley topography, entrenched meanders and knick point. The valley in valley topography marks its development when the shallow bed of the river involves the development of deeper valley within due to increased gradient induced by endogenic upliftment. This valley in valley topography is prominently identified in Yenisey River basin of Siberia Russia. The river is prominently known to have flattest course among the big rivers of the world. The entrenched meanders are those wide meanders where there is strong effectivity of valley deepening. It identifies the case of re-attainment of youth of the topography that have reached its mature stage.

Colorado River of USA correlates with most recognised example of entrenched meanders. Knick point is defined to be transitional point between old and new valleys. It is largely identified along with the base level of erosion, representing the effect of climate change in generating rejuvenation. Theoritically, knick point is utilised to represent even the example of positive rejuvenation.

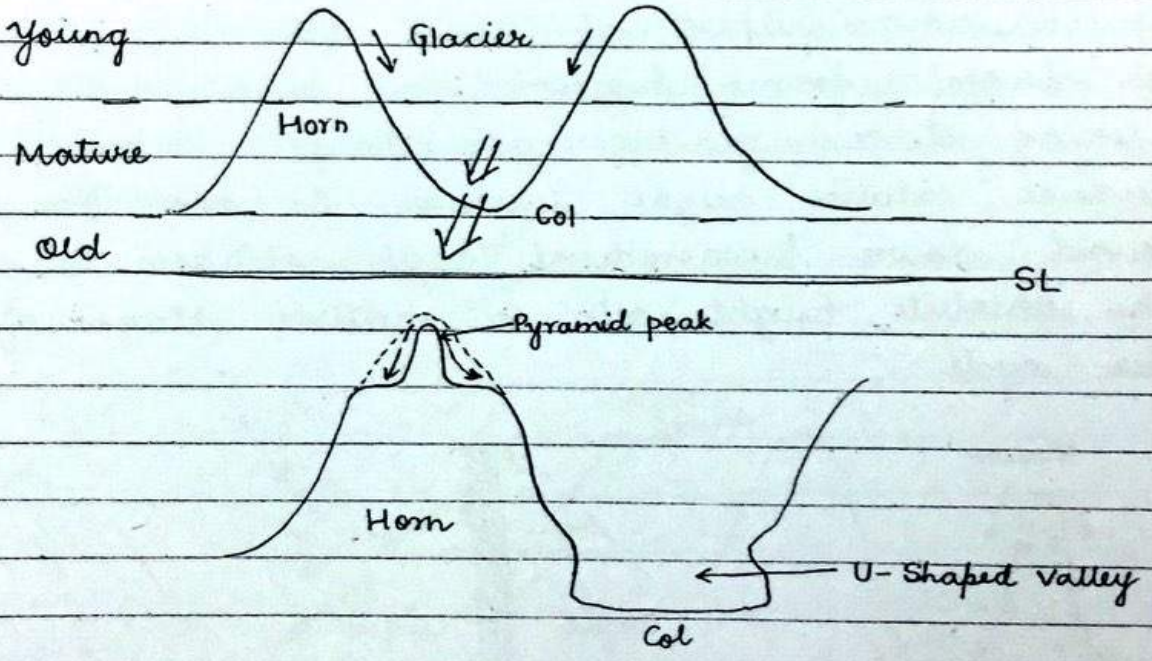


GLACIAL CYCLE OF EROSION

Moving mass of snow and ice is called glacier, which are locationally classified as continental glacier and Alpine glacier. The continental glacier belonging to higher latitude as in Greenland and Antarctica are bigger masses of snow and ice. However, effective in already levelled continental mass, this type of glacier is not referred in the glacial cycle of erosion. The Alpine glacier representing mountain glacier, though have lesser glacial mass, is considered to be more effective leveller and is therefore taken into consideration to the development of the glacial cycle of erosion.

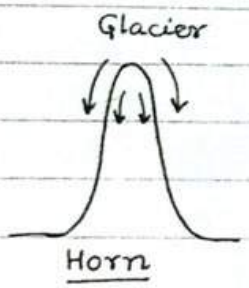
Q. Explain glacier as active agent of gradation.
↳ Do not write about continent glacier

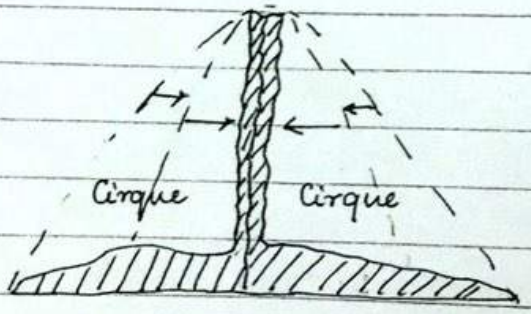
It was Davis who propounded this cycle of erosion in 1900 identifying it to be more theoritical counterpart of fluvial cycle. It is because in the glacial cycle, baselevel of erosion is unclear. Glacier as an active agent of gradation involves plucking effect or scooping effect as the most important method of erosion which generates valley deepening and widening i.e. ablation as additional effectivity. After endogenic upliftment getting over and favourable alpine climate generating snow field, there is the beginning of glacial cycle of erosion with well-defined stages of young, mature and old.



The Young Stage :-
This stage marks its beginning with the beginning of movement of alpine glacier from the snow field via horn to col upto the ablation zone. In the process, alpine glacier generates horn topography,

ol topography as well as the depositional features. ; is however that in this stage development of orn topography dominates the landscape. This topography narks its development in the combined effect of vertical xbrasion i.e. valley deepening and basal sapping i.e. barallel retreat of mountain wall. In the effectivity of these two processes, the developed erosional feature is called CIRQUE i.e. the deep alpine valley with steep standing backwall. Development of cirques along more than one slope of original horn simultaneously leads to formation of Arete that are knife edged remains of original horn between the two cirques. In the genesis of more than one arete, narrowed down apex of horn with significant rough profile forms pyramidical peak. Throughout the young stage, glacial cycle, therefore, marks the dominance of relative height increase. As soon as the narrowed down pyramidical peak collapses, decrease in the absolute height sets in mature stage of glacier cycle.

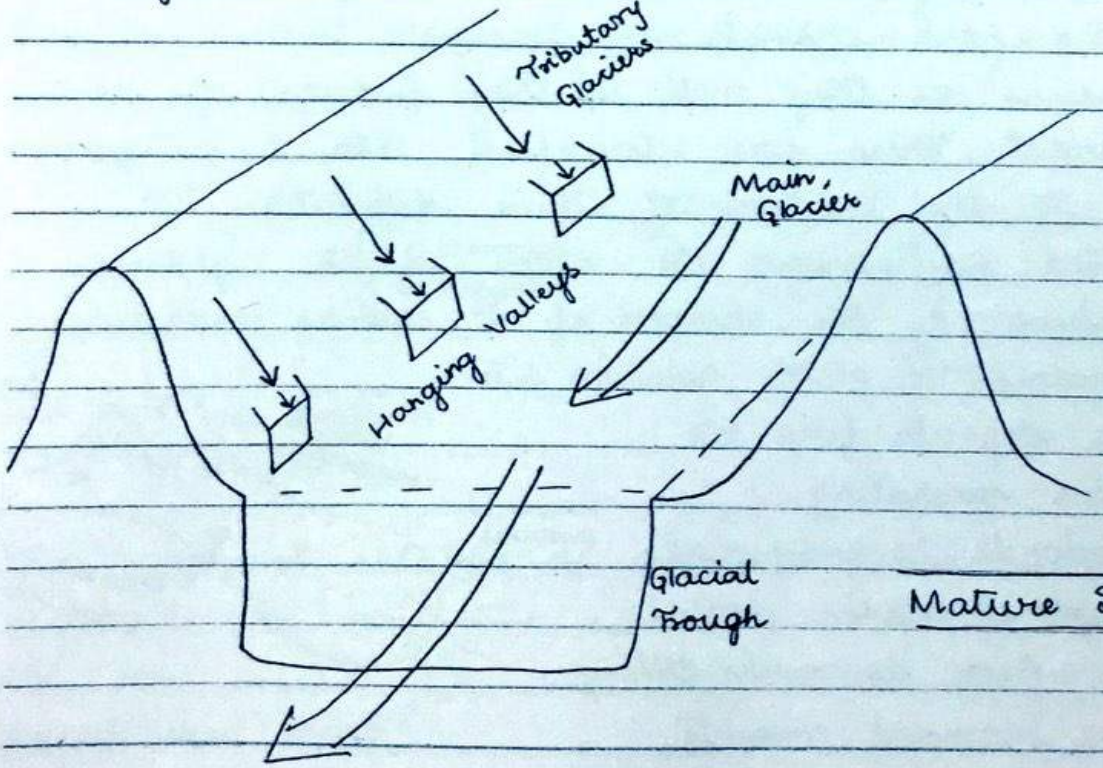




Young Stage

(ii) The mature stage of glacial cycle :

In the mature stage glacial cycle is dominated with the development of col topography. Compared to the horn, col correlates with less steep gradients and thus much fuller accumulation of glacial mass. It is in accordance that the col topography represents to be typical vertical abrasional feature called GLACIAL TROUGH or U-SHAPED VALLEY This U-Shaped valley is classified into main trough and hanging valley. The main trough represents the vertical abrasional valley developed by the main glacial mass, whereas, the hanging valleys forms the small glacial troughs developed by tributary glaciers with lesser erosion capacity. This typical col topography continues to represent increase in relative height carried on by alpine glacier.



Mature Stage

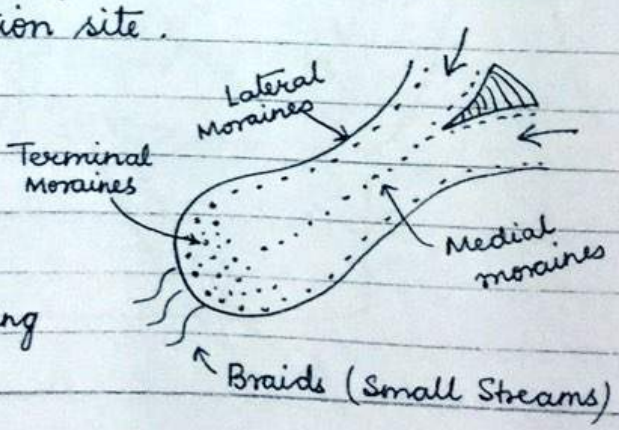
In this stage, developed erosional depressions of both horn and col, develops well-defined GLACIAL STEPS. These steps becomes evident only after termination of glacial mass, largely during summer season. It is therefore that glacial steps always corresponds to fresh-water lakes called TARN LAKES of Cirques & Paternoster Lakes in rest of the depressions.

The Old Stage :

Continuation of bassal sapping in horn when makes the backwall of cirques completely removed, termination of horn with sufficiently deepened col, sets in the old stage of glacial cycle. In this stage denuded height generates unfavourable climate with the beginning of termination of glacial mass making deposition as the only activity, the alpine glaciers are engaged in. The developed feature is called MORAINIC DEPOSITS. Moraines are defined to be the unconsolidated rock deposits of variable texture deposited by the glaciers as they melt in their process of down-slope movement. These are classified into 3 categories according to the location of their deposition.

Lateral moraine i.e. along the sides of the glaciers
Medial moraine i.e. the merger of 2 lateral moraines.
Terminal moraines i.e. at the ablation site.

The morainic deposits fills all the depressions generating featureless lowlands i.e. end-product of glacial cycle of erosion called CRYNOPLAINS which do marks dotting resistant thus remnant mounts called NUNATAKS.



Geography

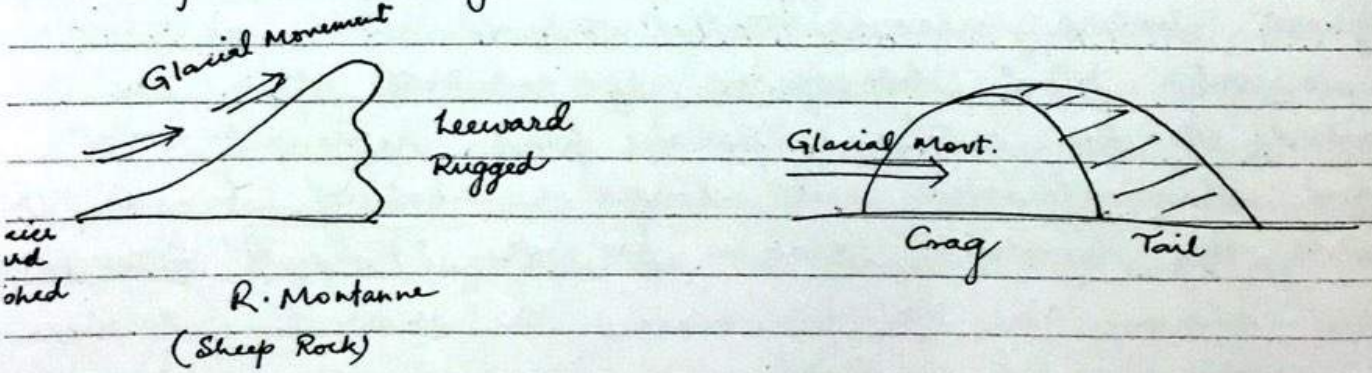
Lecture (15)

ate
3rd March 2014

CONTINENT GLACIER AS AN ACTIVE AGENT OF GRADATION:

In the higher latitudinal areas, continent glacier form effectin agent of gradation moving in already levelled continental surface. These glacial masses are not involved in stages of cycle of erosion. They, however, incoporates erosional capacity in polishing distinctive size pebbles in accordance to their movements. The identified minimal erosional features developed by continental glaciers includes Rochee Montanne & Crag and Tail topography.

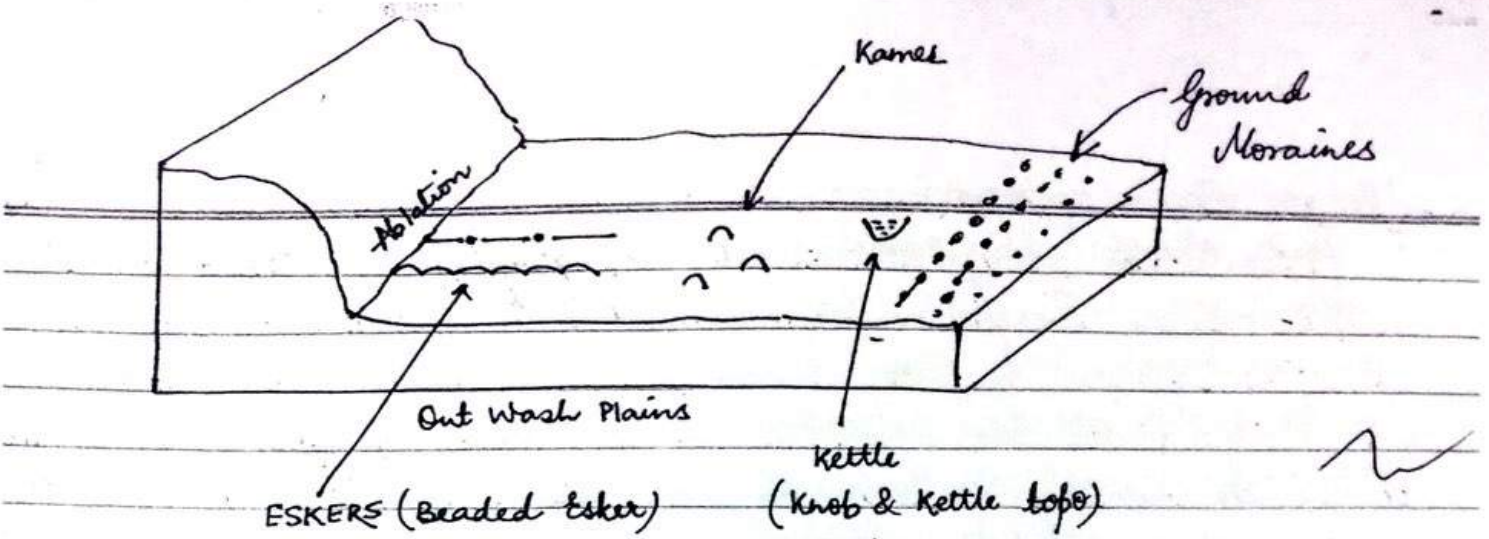
Rochee Montanne represents the rock that experiences glacial erosion along both its slope with the glacial-ward side being polished & smooth, & leeward side plucked, thus, rugged. This feature because of its shape is also called Sheep rock. Compared to it, Crag & Tail topography involves one polished side of the rock due to the movement of continent glacier. The extension of such rock beyond the reach of continent glacier maintains its original profile called tail. The Crag & Tail topography, therefore, are typical to marginal areas of continent glacier.



The seasonal ablation of continent glacier results in the deposition of distinctive textured materials in diff shapes. All these deposits are collectively called TILL DEPOSITS.

his includes both glacial & fluvio-glacial deposits. The
lacial category includes the only, though, most recognised
'acial depositional features called drumlins These are the
older Boulder Clay deposits representing fine texture but
rge sized deposits known for absolute homogenous sequence
deposits making these deposits nick-named as BASKET OF
gs topography. typical to the landmasses along Arctic &
ulhern Ocean, it is in UNGAVA peninsula (Canada) that
rld's largest Drumlins are identified.

The fluvio-glacial category correlates
the generated BRAIDS due to the melting of
tinental glacier. These deposits are typical to the
TWASH PLAINS. It is these plains that represents glacial
osited soil with significant fine textured deposits.
- distinctive deposits of Outwash plain are demarcated
accordance to their shapes of deposits. Among the
ost ~~reg~~ recognised features of outwash plain, ESKERS
at are continuous ridges of deposits, KAMES that
= individual mounds of deposits, GROUND MORAINES that
finest texture unconsolidated deposits and KETTLE
t is water filled depressions of outwash plain are
luded. As the entire outwash plain represent water
gged characteristics with large number of braids, it
vails the excellent location for the study of GEOHYDROLOGY



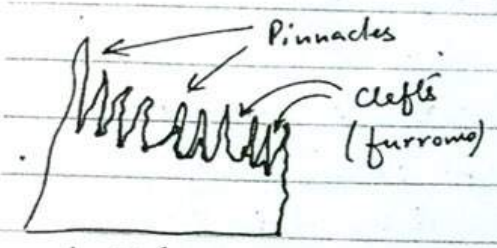
{ Only if Glacial Cycle of Erosion : Avoid Continent Glacier }
↳ Davision Approach

KARST TOPOGRAPHY : (Map of Europe: Eastern Shoreline of Adriatic Sea ↳ Croatia & Bos. – Herz.)

↳ KARST CYCLE :

The Karst geomorphic cycle is identified to be unique in its characteristics as it involves the specific requirements of thick bed of limestone exposed on the surface with humid climatic conditions. This cycle therefore is highly localised with its name derived from Karst Province of erstwhile Yugoslavia along Adriatic Sea Shoreline. This cycle is credited to Beede (1911) and Cvijic (1918), the decipies of David. They identified in their respective Study that Karst Cycle forms the simplest geomorphic cycle as it involves mono-process i.e. Solution or corrosion. The cycle however involves difficulties as the baselevel of erosion is unclear. Moreover, the movement of underground water cannot be standardized. Like all the other geomorphic cycles this cycle is also correlated with young, mature & old stages. The young stage of Karst cycle marks its beginning with the beginning of surface solution by both rainwater and running water.

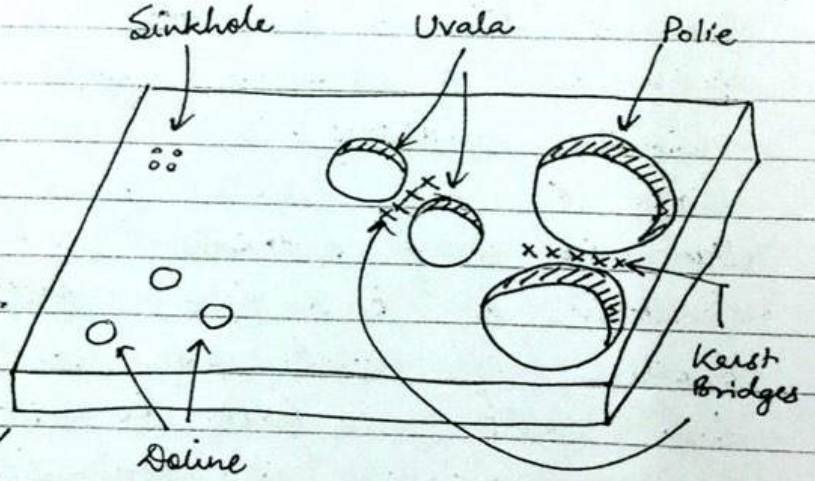
this stage, the solutional topography developed on the rface are not just distinguished in accordance to the fective agent but also to the nature of limestone beds. e Rainwater solution effective in this stage of Karst cycle, it is rrelated to vertical beds of limestone. The developed solutional atures are called Lappies. These are typically associated ith pinnacles that are the leftout limestones seperated by issolved furrows called CLEFTS. Commonly, however limestone ds are horizontally aligned. In such types of beds, distinctive zed surface solutional craters are generated. In the increasing der of size, it includes Sinkholes, doline, Uvalas and olie. The larger size surface solutional craters as valas & polies, also corresponds to KARST WINDOWS & RST BRIDGES.



Lappies
(Uncommon)

→ Bedding Vertical } : Rainwater

Bedding horizontal } → Rain Water



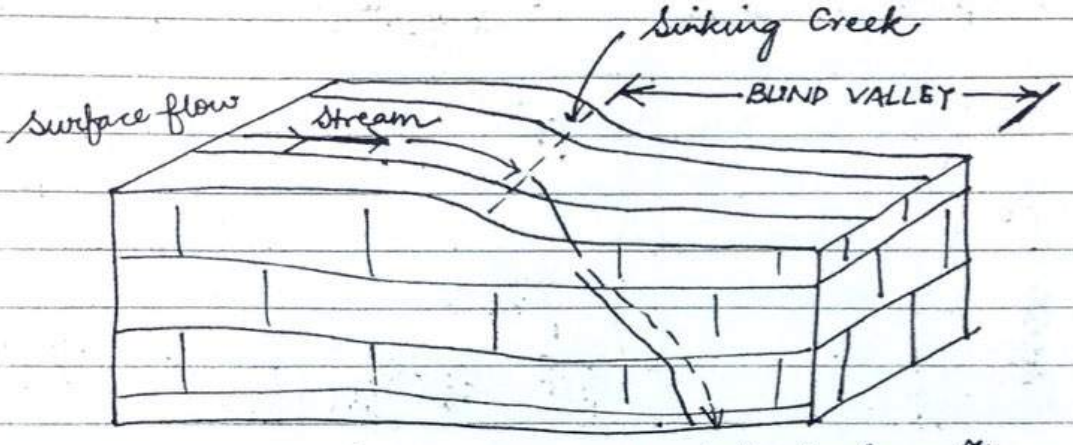
Karst Windows → Depressions

Surface Solutional Craters

Young Stage → Rainwater + Running Water

Running Water surface/topographical features

The surface solution carried on by running water in the Karst region generates additional topographical features which includes blind valley i.e. river valley permanently deprived of active channel and sinking creek i.e. the point where surface stream converts as sub-surface flow. When the Karst topography is dominated by development of numerous sinking creeks, surface runoff disappears with sub-surface solution becoming prominent. That is the beginning of mature stage of Karst Cycle.

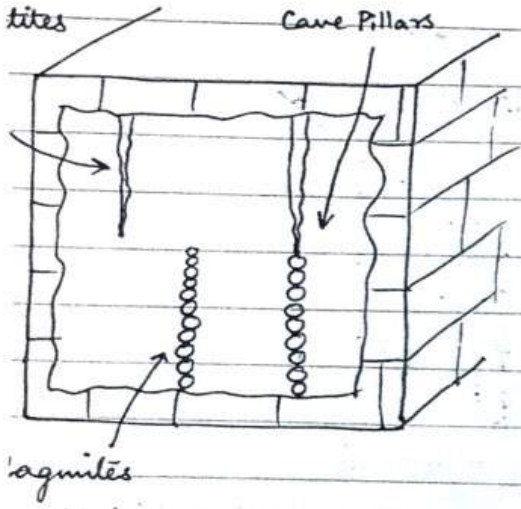


Sub-Surface Flow

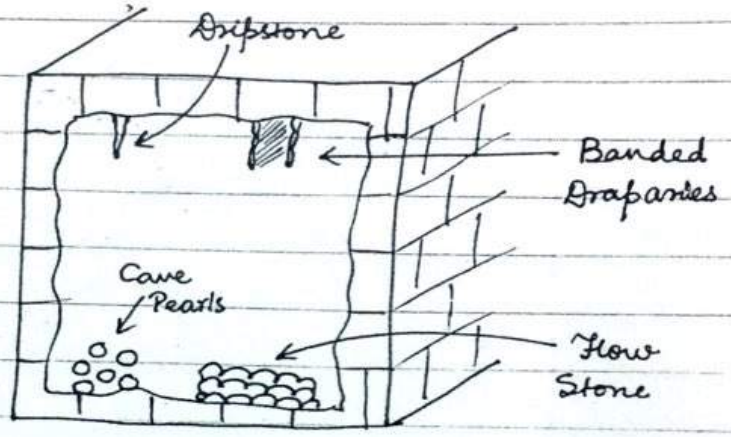
Mature Stage of Karst Cycle: This stage correlates to underground water as an active agent of gradation. The source of this underground water includes both penetrated rainwater & sinked-in running water. The only erosional feature that underground water as an active agent of gradation develops is called Karst Caves. These are sub-surface solutional hollows which are known for their extreme humid climate & involves an entire range of depositional features developed by underground water as an active agent of gradation. All these cave deposits are called speleotherms which are categorised as major speleotherms & minor speleotherms.

major category includes stalactites, & stalagmites and
e pillars whereas minor speleotherms representing immature
iants of the major speleotherms includes Dripstone,
ded Draperies, Flow stone and Cave pearls.

leotherms. All cave deposits



Major Speleotherms



Minor Speleotherms

Topography → Surface & Sub-surface soils

cycle → (" " ") + (Young, Mature & Old)

ugroumd water → Exclude surface

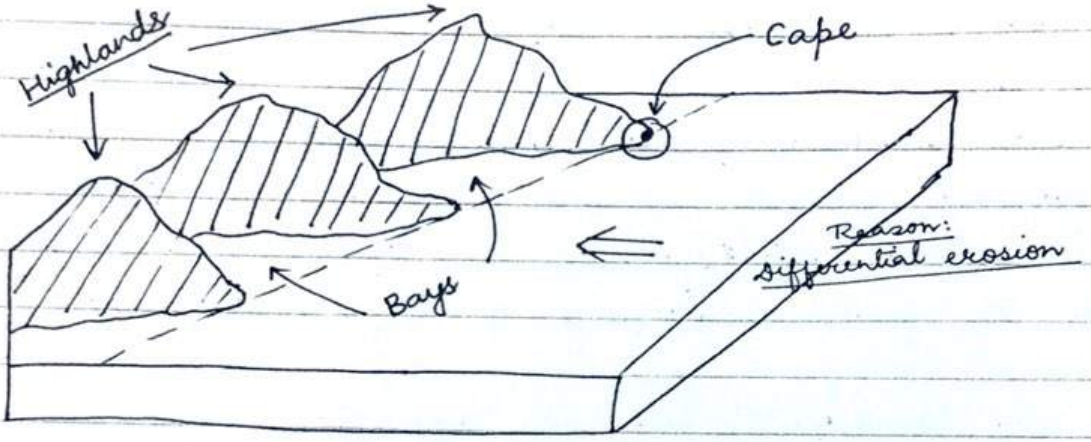
In the mature stage of Karst Cycle, apart from the effectivity of underground water as an active agent of gradation, surface solution continues. It is either due to solutional termination of the surface limestone strata or due to collapse of remaining limestone strata, when there is decrease in absolute height, the Karst Cycle enters old stage. In this stage, apart from the destruction of Karst Cave and all the ceiling deposits, there is the possibility of reappearance of disappeared surface stream. The Karst Cycle marks its termination with such developments. However as the undear baselevel of erosion, the end-product i.e. exposed cave ground largely reveal prevalence of dotting carbonate mounds called HUMS. With the exposure of humus, there can be the fresh beginning of the Karst Cycle.

Humus are remmanents but not resistant.

× × × × ×

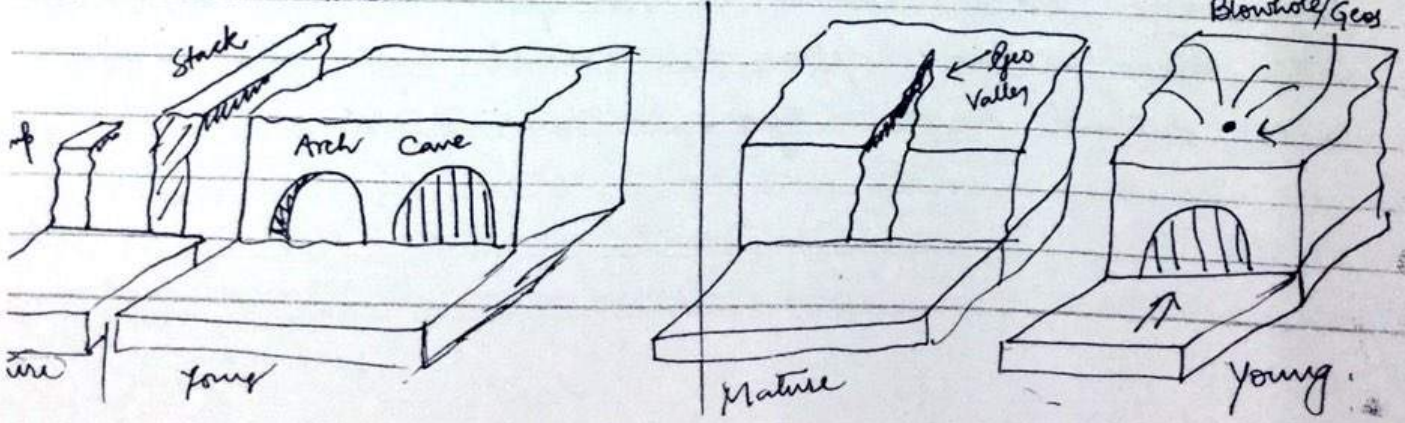
4. COASTAL CYCLE OF EROSION: Based on the identification of positive change in the Mean Sea Level, post pleistocene ice-age, Davis developed coastal cycle of erosion. He therefore emphasized that the shoreline on the map of world collectively represents shoreline of submergence either climatologically or tectonically. When the specific type of shoreline is developed, beginning of coastal cycle is outlined. Sea waves as an active agent of gradation involves "surfing effect related hydraulic action" as the course of erosion and "backwash" as the course of transportation and deposition. Like other erosion cycles, the coastal cycles also includes, 3 well defined stages: young, mature & old.

young stage of coastal cycle dominantly correlates with development coastal erosional features. The category of these features includes & Bay topography, coastal cave with either arch or s formation along with development of sea-cliff with notch. The Cape Bay topography forms the commonest topographical features loped by sea waves as an effective agent of gradation. It des the example of differential erosion.

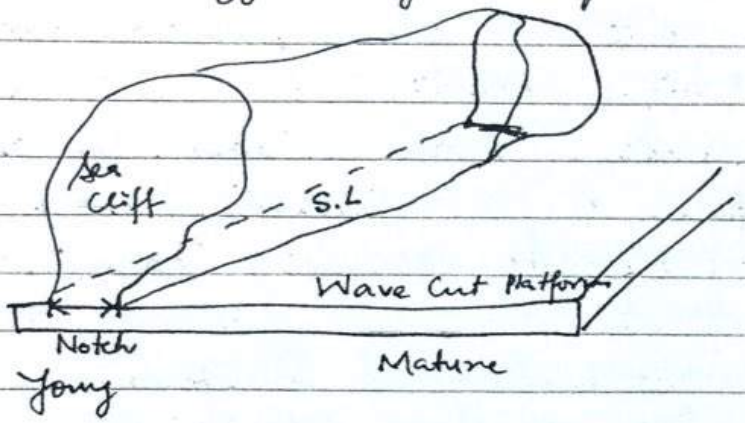


Features that develops in young stage: Cape & Bay.

In the coastal areas, where structurally variable resistant rock ade coastal mountains are specified, there is the projected development of the coastal features called coastal cave. It is this feature that in accordance to the subsequent evelopments either facilitates or formation of coastal bridge alled coastal arch or marks the development of blow-ole also called geos. These developments in the coastal areas parks their continuity in the mature stage of coastal rosion as well.



In the homogenous structural coastal mountains, young stage also marks the development of sea-cliff with notch, that is the point where maximum hydraulic action is experienced by the coastal mountains. Transition of coastal cycles from young to mature stage is primarily correlated to further development of erosional features as narrowing down of projecting headlands decrease of absolute height with arch paving way to stack that is coastal pillar or stump i.e. eroded stack or geos paving way to the geo-valleys terminating the existence of coastal cave. This transition is also correlated to the retreat of sea-cliff in generating wave-cut platform



Sea - Wave
Wind
Find out which are the locations that qualifies as desert where winds are active agents of gradation.

E arch 2014

Lecture=16

Coastal cycle contd.

d Stage : The old stage of coastal cycle marks its ginning theoritically with noticed decrease in absolute ight. This stage, therefore, is prominently recognised th development of depositional features. Both transportation deposition carried on by sea waves corresponds to its reating movement that is called backwash. The coastal posits are broadly classified into 2 categories :

1 Onshore Deposits

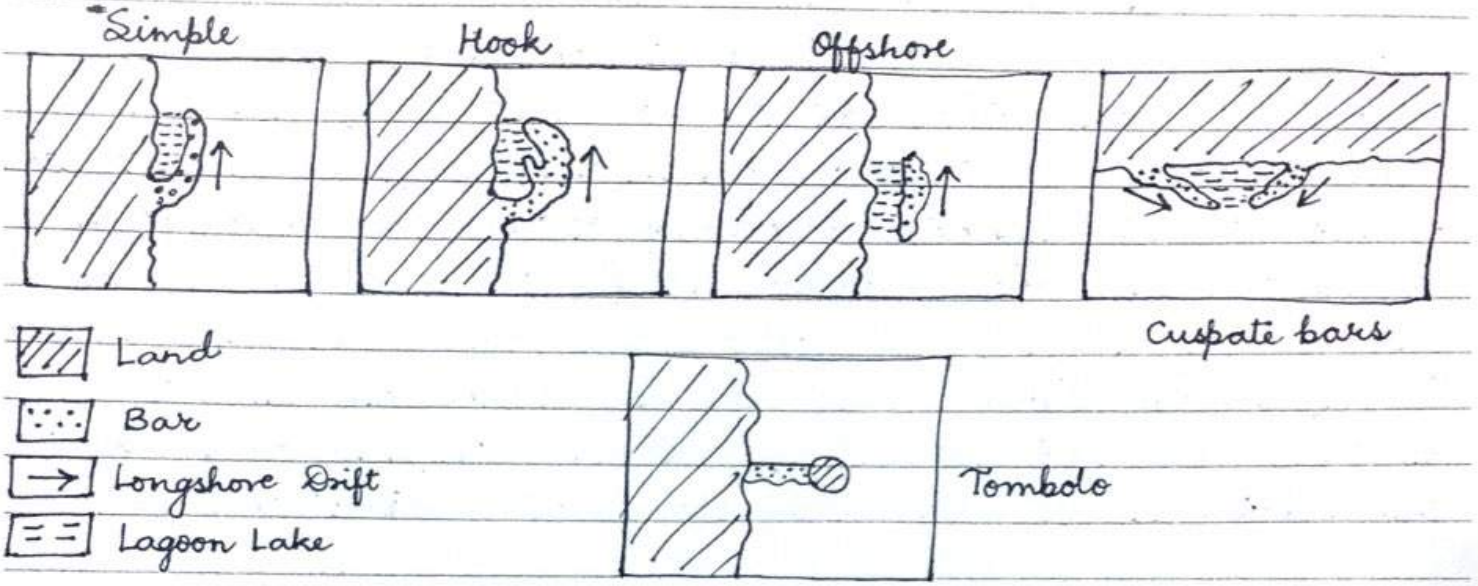
) Off-shore "

nshore Deposits : The on-shore deposits are called beaches ese are very well sorted, temporary, unconsolidated, rock posits deposited between coastline & shoreline. These are ssified as beach cusps & beach ridges. In accordance the specific platform of their deposition, beach cusps are mmon over the headlands generating "cape and swale iography" whereas beach ridges are common on wave-cut tforms generating wave-deposited platform.

ffshore Deposits : The off-shore deposits are called bar or t deposits. These represent elaborate effectivity of long ore drift that is recognised to be movement of sub-rface water parallel to the shoreline. After the surfing ect, the bar deposits form much more consolidated, thus, rmanent feature. When compared to the beach deposits, these posits are classified in accordance to their shape, size alignment. Among the prominently recognised types of deposits simple bar, hook, offshore bar, tombolo nd cuspate bars are included. The coastal cycle of osion marks its conclusion with the development of rofile of equilibrium i.e. erosion and deposition balancing ch other. The generated featureless lowland is called

coastal peneplain with dotting resistant, thus, remnant coastal monadnox.

Lagoon : Salt water lake which is carved out of sea/bay/gulf



Types of Bars

① Adam's Bridge (India-Sri Lanka) → Tombolo

② Vembanad Lake (Kerala) → Simple → Hook

③ Chilika

④ Long Island → Offshore bar near New York

EOLIAN CYCLE : Eolian cycle of erosion or arid
cle of erosion is credited to the strongest disciple of Davis,
King. He identified the cycle to be applicable in all
deserts of the world where evaporational loss is more
an precipitational gain. He identified deserts to be locationally
pical west margin deserts as Sahara Desert or sub-tropical
ntiental desert as Gobi Desert. Compositionally, deserts are
assified as Erg Desert i.e. sandy desert, Reg Desert i.e.
bles/ stony deserts and Hamada Desert i.e. big barren land-
rpe. In the deserts, absence of surface moisture, thus,
ennial vegetation justifies wind to be the most effective
ent. However, as the wind movement cannot be standardized
generating sequential landforms, Eolian cycle have been
loped by utilising the effectivity of Secondary agents
fluvial action generated by sudden torrential rains.

Eolian cycle is specified in the areas called BOLSON
se are arid valleys surrounded by mountains. The
serts are the location that commonly experiences non-
pendable, unpredictable sudden torrential precipitation caused
e to sudden heating of sand. It is this sudden
rential rains that generates flash-floods setting in the
vial action, thus, Eolian cycle of erosion. In the young
ge, flashflood water is projected to be prominently
gaged in vertical abrasion, descending down the slope of
r arid mountains. This vertical abrasional feature
led wadis are recognised to be a variant of V-shaped
ley which remains deprived of running water for major
rt of year. The transported material by the flash-flood
ter generating the wadis is largely deposited at
EDMONT location as fan-shaped deposits called
y Delta.

These dominating activities in the young stage of arid cycles correlates to continuous ↑ in the relative height. When in the process absolute height marks its reduction, mature stage with dominating development of Bolson floor features is demarcated. In the Bolson floor, the flashflood water marks the development of horizontal abrasional plain called pediments. This marks simultaneous formations of depositional plains called Bajadas. Among the other features identified with Bolson floor, temporary lakes called playa lakes leading to the formation of hard salt layer called salinas and dry river valley called arroy are developed. In this stage, development of pediment & wadis continuously results in retreat of the mountain wall. Identified by LC King, this transition paves way to old stage of Eolian cycle where enlarged pediment paves way to the formation of pediplains, that is featureless erosional surface which incorporates resistant thus remnants, isolated mounds called inselbergs.

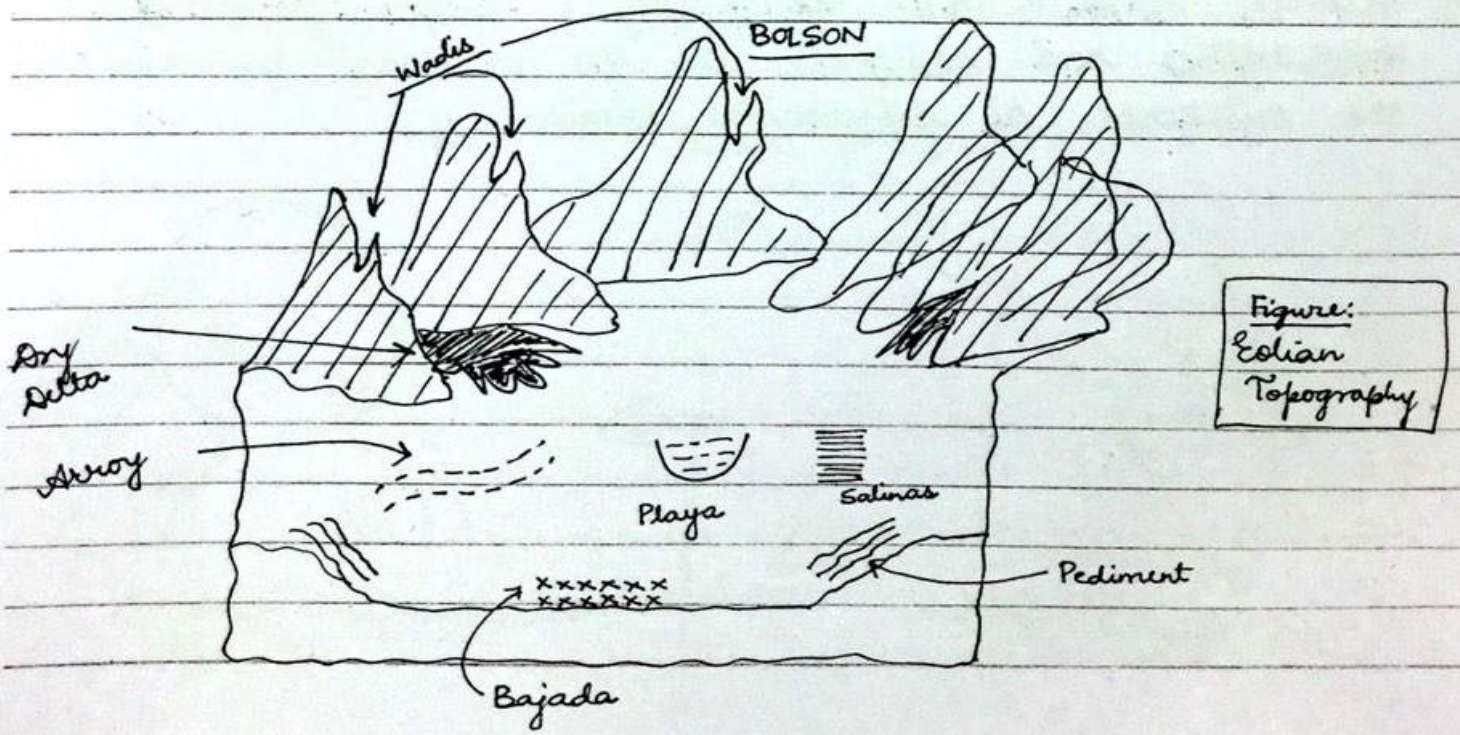
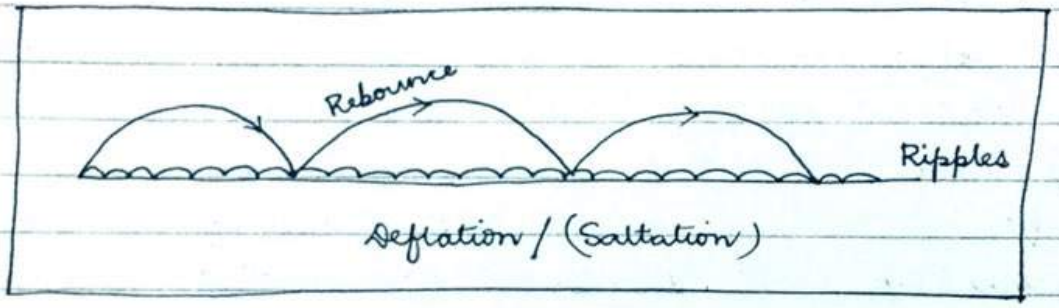


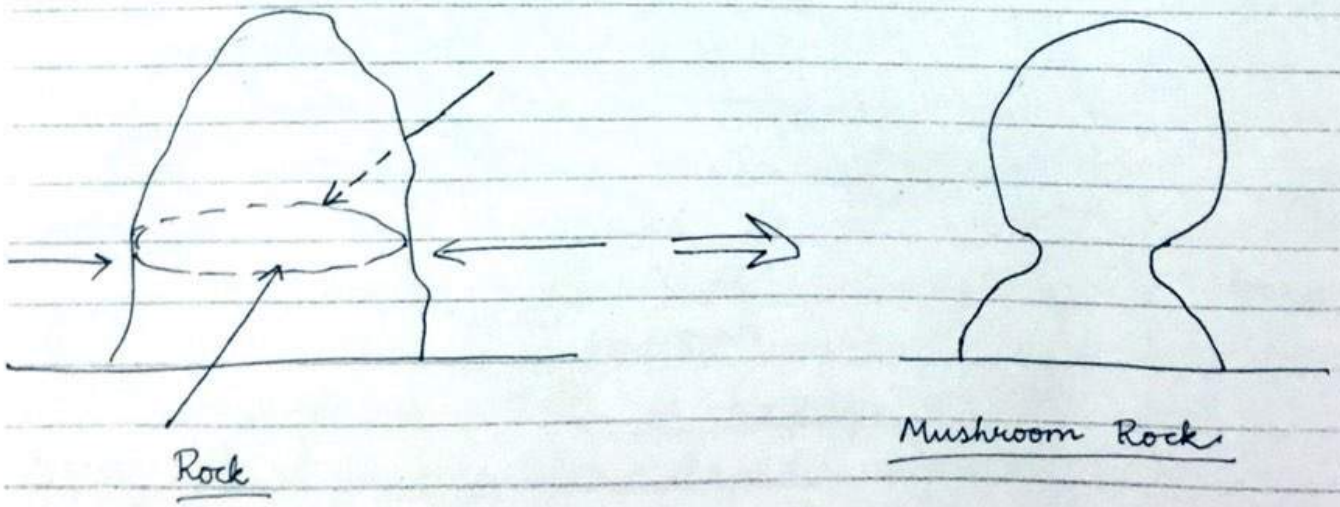
Figure: Eolian Topography

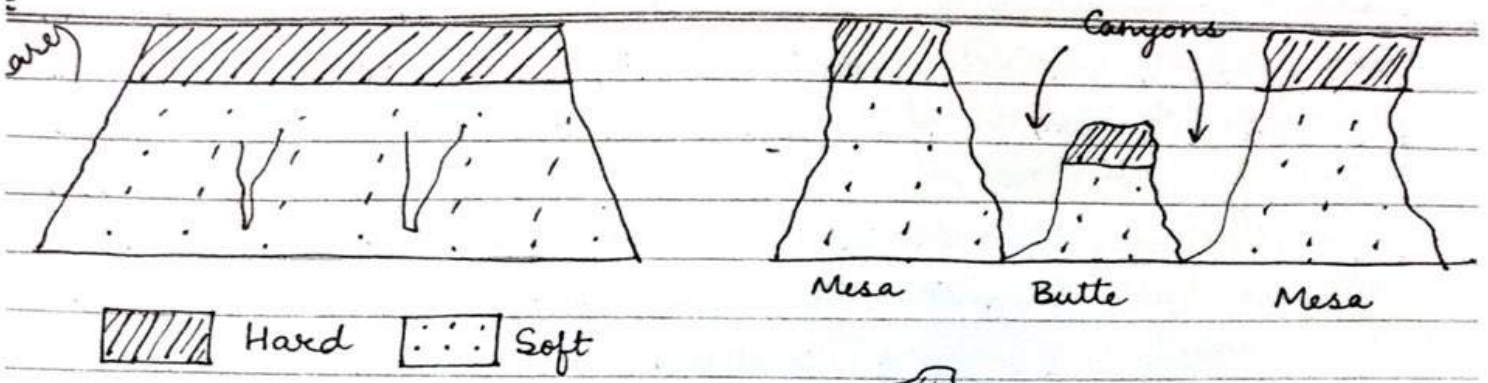
IND AS AN ACTIVE AGENT OF EROSION :

Horizontal movement of air is called wind which acts as most important agent of gradation in the deserts where moistureless sand and absence of vegetation facilitates uninterrupted deflation i.e. blowing effect. The deflative movement prominently includes saltation i.e. long leaps which creates sand blasting effect. On the absolute ground, however, rolling sand particles generates ripples.



The sand blasting effect generates erosional features which commonly includes mushroom rock as an absolute example of saltation effectivity and it also includes Mesa & Butte topography, Zueger-Yardang, Stone lattice and Ventifacts as the erosional features that are outcomes of differential erosion.

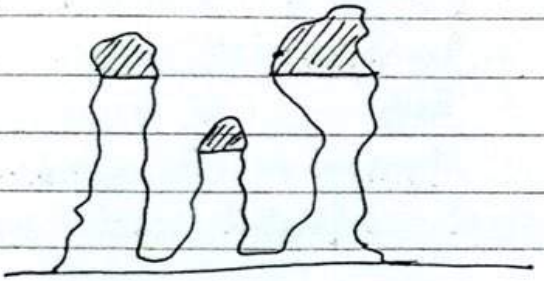




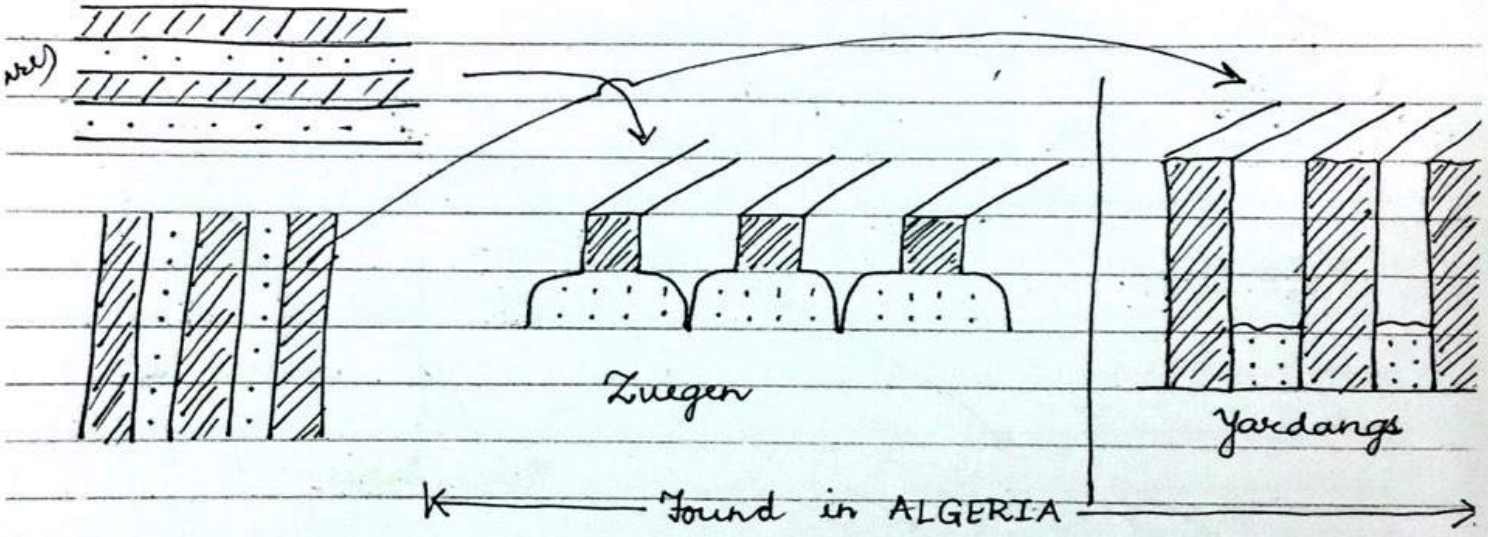
US Deserts.

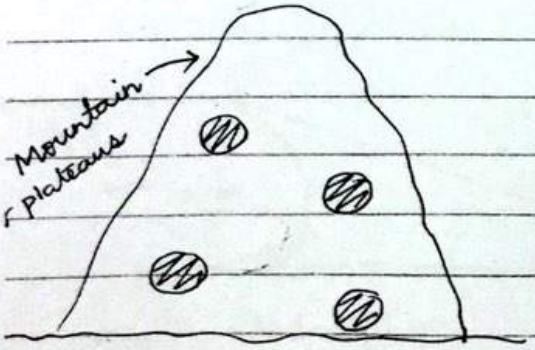
→ Colorado Desert

→ Mhave Desert



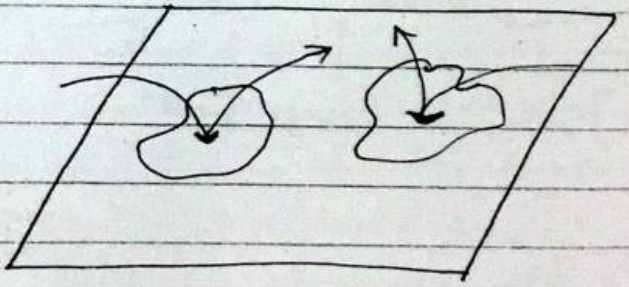
Hoodoos (Zig-Zag)





Stone Lattice or Stone Net (Common)

#



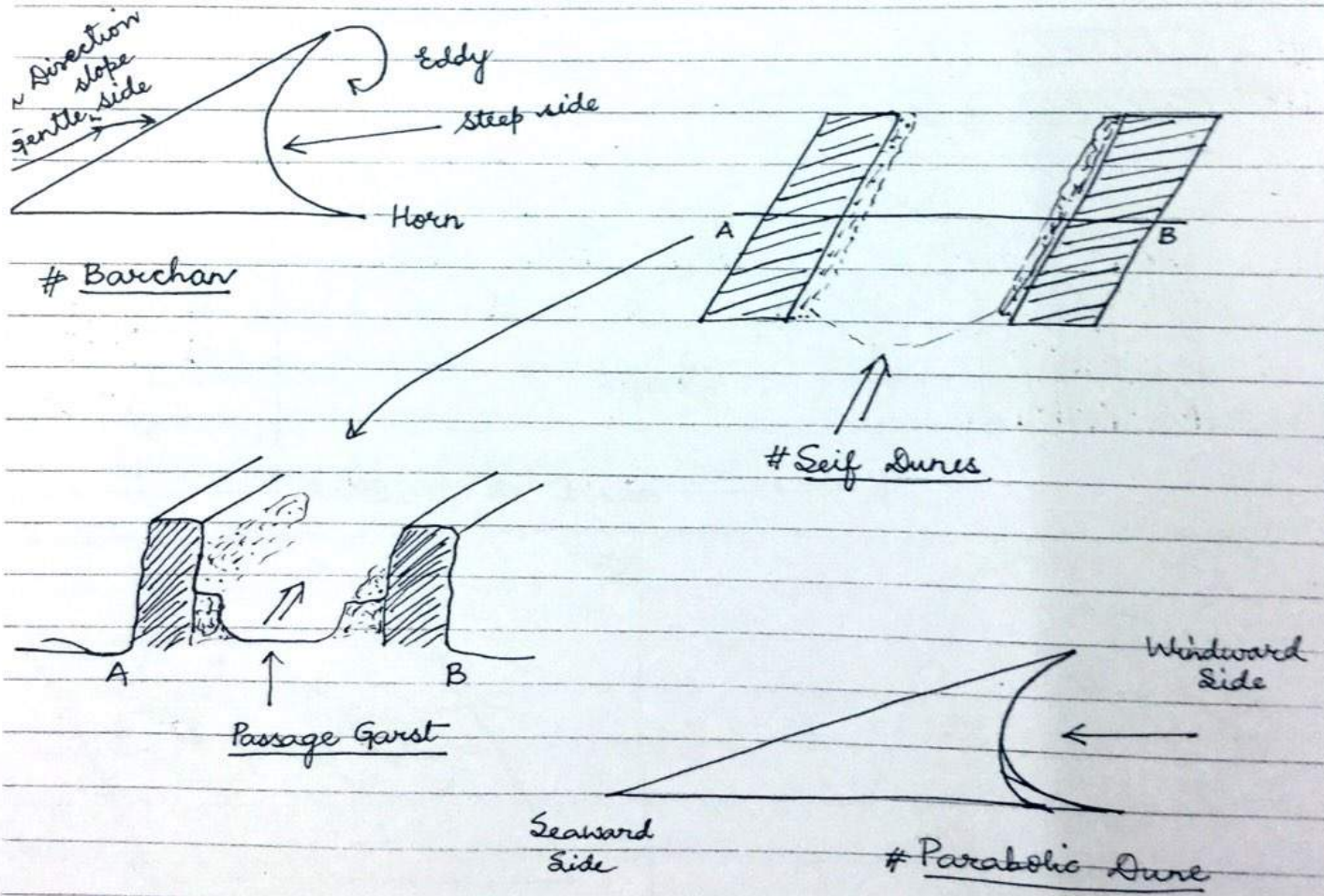
Ventifacts (Common)

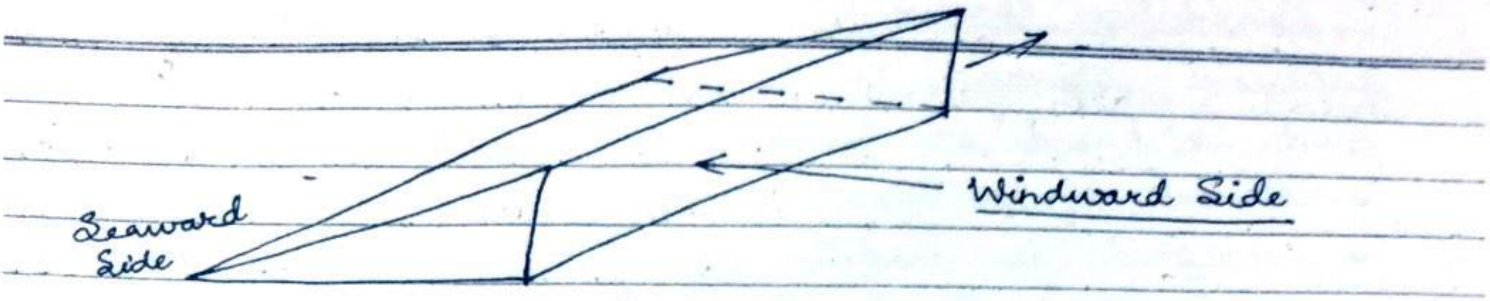
Wind as an active agent of deposition correlates to the formation of sand deposits. These deposits are classified to two well-defined categories: ① Sand Dunes & ② Loess. Sand dunes are classified in accordance to their shape as well as their location. The distinguished categories are:

(a) Crescent: Barchans (in desert)
Parabolic (in coastal areas)

(b) Linear: Seif (in desert)
Transverse (in coastal areas)

Loess is wind deposited soil outside the desert.





"Transverse Dune" on wave cut ~~platform~~

Transverse dunes are ⊥ to wind flow while seif dunes are in the direction of wind flow.

Eolian Cycle → "Wind" + "Fluvial action by HC King"

Wind: Erosion
- Deflation
- Sand blasting
  - Mushroom Rock
  - Mesa & Butte
  - Zuegen & Yardang
  - Stone Lattice
  - Ventifacts

↳ Due to differential erosion

Deposition
- Sand dunes
  - Crescent: Barchans & Parabolic
  - Linear: Seif & Transverse
- Loess

Lecture # 17

13/03/2014

Denudation Chronology & Erosional Surfaces:

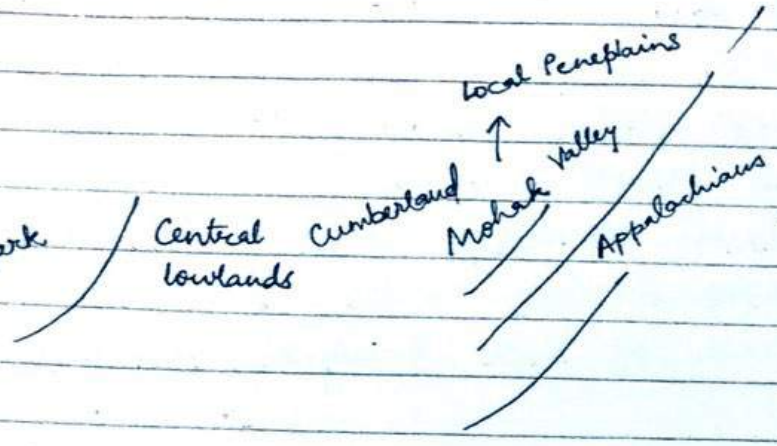
istorical approach to the study of landform features
hich is based on fundamental recognition of sequential
evelopment of landform is denudation chronology.
e approach is credited to RJ Small, one of the most
rominent modern geomorphologist.
e recognised that the primary objective of the study of
enudation chronology is to reconstruct the development of
opography which marks its evolution, denudation and
-development.
e based denudation chronology onto fundamental
eomorphic principles: (A) Davisian Cycle of Erosion and
Hutton's uniformitarianism { Laws of Nature do not
change with time }.
enudation chronology is not applied to the relief that
ere developed in tertiary period.
ature and modifications of the topography is generalised
be dependent on:

(a) Age of the surface
(b) Relative hardness of rocks
(c) Stream frequency or drainage density

e denudation chronology is strongly criticised by another
odern geomorphologist Bloom. He recognised the approach
be highly deductive and can be applied for the analysis
; general sequence of landform study.
or the specific cases, following this approach can result
to misleading conclusions.
For example: Notre Dame mountain, Allegeney and
Blue Ridge mountain of Appallachians are significantly
taller than rest of the ranges not because, they are
made up of resistant structure but that they have

Ozark
Cumberland } Earlier Part of Appalachians

experienced negative rejuvenation during tertiary period.



Cumberland & Appalachians : Mohak Valley (Local peneplains)
Ozark & Cumberland : Central lowland.

) The erosional surfaces are defined to be end product of erosional cycles which was given the expression peneplain by Davis.
R.J. Small identified erosional surfaces to be the features cutting across all the geological structure, distinguished from erosional features which are structurally controlled.
) Erosional surfaces are identified to be cryoplain for glacial cycle, pediplain for eolian cycle, peneplain for fluvial cycle and "Etch" plain (Thomas and Pugh) for Savannah Cycle.
) Erosional surfaces are classified into 3 prominent categories:
(i) Local peneplain
(ii) Regional "
(iii) Reuplifted "

The local peneplain forms first stage of peneplain development where in the influence of most effective agent or least resistant strata, part of relief is eroded to the base level. Mohak Valley and Central lowlands (USA) along the

Karst Cycle does not have erosional surface.
Tropical continental climate – Savannah

ppalachians forms most recognised example.
he regional peneplains form the ultimate stage of development
f peneplain where near complete relief is eroded to the
ase level. Yenisey river valley relating to western Siberian
lain forms the most projected example.
he re-uplifted peneplain denoting negative rejuvenation
r polycyclic landform involves valley-in-valley topography
eveloped in mid-course of River Yenisey as an excellent
xample.

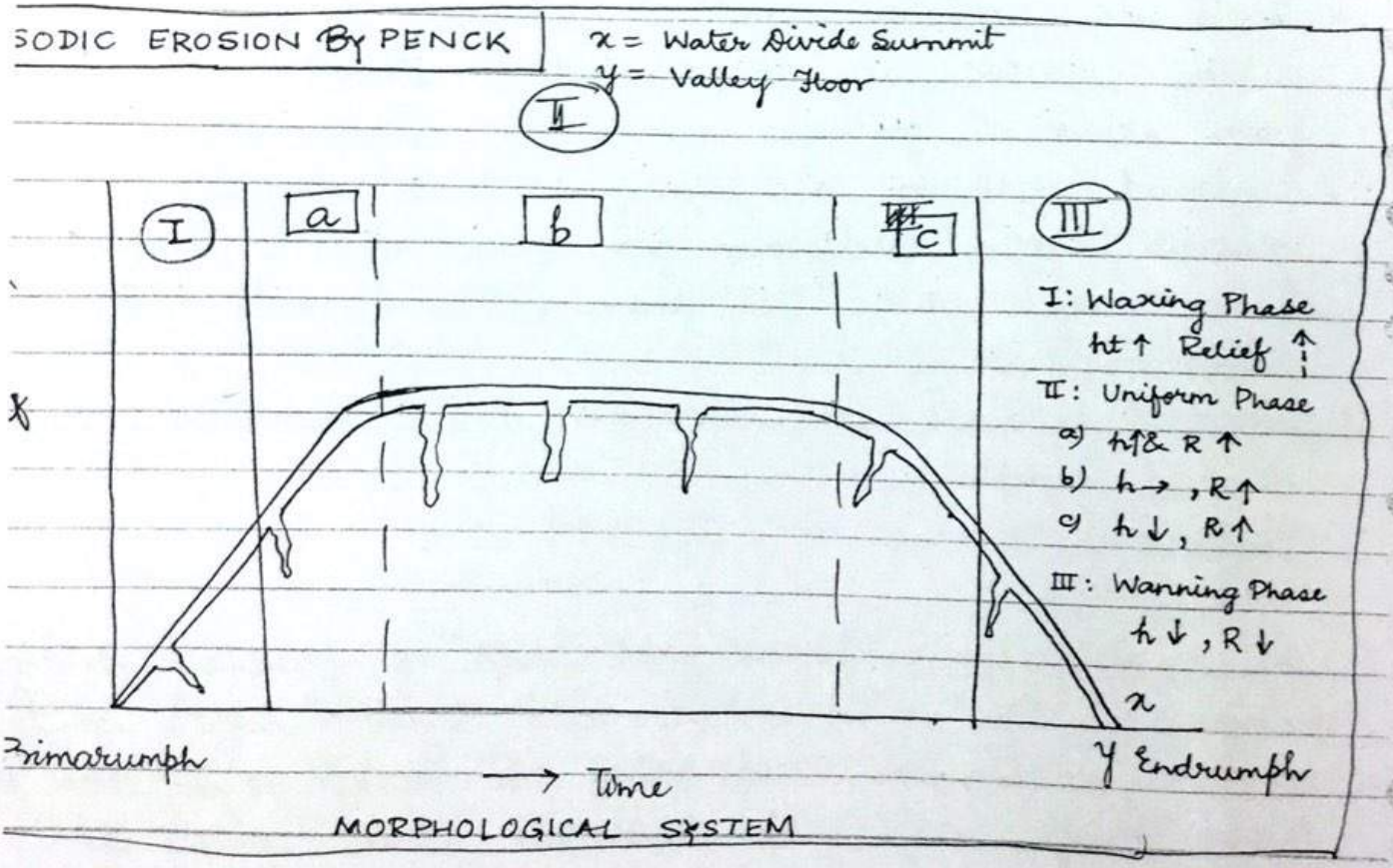
MAPS

Vest Siberian Plain : Peneplain
Mid-course of River Yenisey : Re-uplifted peneplain

ycle of erosion – Don't go beyond Young, Old, Mature
rosional surface → Must talk about regional & reuplifted

SODIC EROSION By PENCK

x = Water Divide Summit
y = Valley Floor

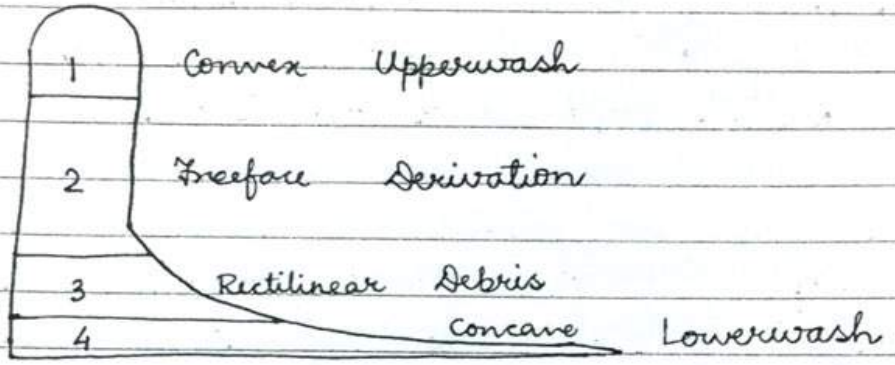


MORPHOLOGICAL SYSTEM

SLOPE DEVELOPMENT : CONCEPTS & APPROACHES

Concepts of Hill Slopes :

These concepts in geomorphology involves the definition of hill slopes to be angular inclination of the topography b/w the hill-tops & valley-bottoms. These angular inclinations are precisely caused by structure, age & process. The idealised hill slope is correlated with 4 different elements or segments. These includes :



Elements

The convex elements is the hill crest elements which corresponds to waxing phase of development of landform. It generates its profile with simultaneous effectivity of upliftment & downcutting and is therefore also recognised as upperwash slope.

The freeface represents the hill slope segment that is near absolute vertical slope of bare rocks. It is due to its gradient that it is completely deprived of weathered rock materials. This slope element is in accordance also referred to be slope of Derivation which correlates to the parallel retreat or back-wasting of the slope.

Rectilinear: Transitional element b/w freeface & concave element. It represents constant slope. Lesser gradient in this hillslope

nent makes it prominently incorporating deposition of oken rock materials. It is in accordance that it is also lled debris slope.

concave element is the foot element of the hillslope ich may or may not have deposited materials. It is related primarily to the waning phase making it ar completely deprived of recognisable gradient. It is e to its location that it is recognised also as lowerwash ope.

These hillslope elements represent variable combination in real ground perspective so much so that every hillslope m revealing the combination of one or more than one llslope element making every hillslope 'complex compound rm'. It is therefore that to generate distinction, dominating lslope element is taken into account. To name hillslope ms, young reliefs are largely convex hillslope forms, l reliefs are largely rectilinear hillslope forms and cient reliefs are largely concave hillslope form. It is s combination of hillslope forms that are analysed in fferent geomorphic approaches of the hillslope development. ese approaches are classified into 2 broad categories: uantitative & qualitative.

ANTITATIVE METHOD: The quantitative methods are the ositical methods which involves lab-based calculation of gradient of hillslopes. These methods are more applied the field techniques of geography, that is, cartography. ese methods are primarily contributed by Wentworth, iimz & Henry.

B) QUALITATIVE METHODS :

The qualitative methods are the empirical methods that are based on actual slope analysis. These methods take into account tectonic processes, erosional processes & depositional processes to be generating hillslope forms. Within this category, monoprocess and & polyprocess slopes are distinguished. The most followed ideologies:

(A) Slope Decline theory of Davis } Downcutting as process (erosional)
(B) Slope Replacement theory of Penck }

belongs to monoprocess category that is emphasizing exogenic processes in the development & modification of hillslope forms (with prime focus on erosional processes)

1) Slope Decline Theory of Davis :

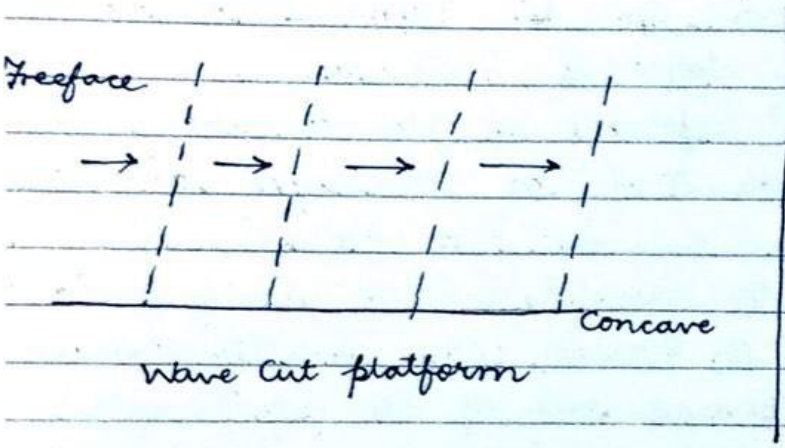
As part of his normal cycle of erosion, Davis emphasized that like cyclic landforms, hill and valley slopes undergoes cyclic process of development. In this cycle, there is progressive decline in the slope angle and sequential change in the hillslope form from convex to rectilinear and concave. In the young stage, steep convex slope evolves due to active downcutting or valley deepening. In this stage there is limited slope retreat & continuous increase in the slope angle. The beginning of mature stage corresponds to the erosion of water divide summits that marks the decline in both slope & slope angle. In this stage, dominating horizontal abrasion continuously marks decrease in the slope generating much smoother slope profile corresponding to rectilinear hill slope form. With such development, the graded slope when only sustains transportation & deposition of the weathered rock materials, old stage of slope decline is demarcated.

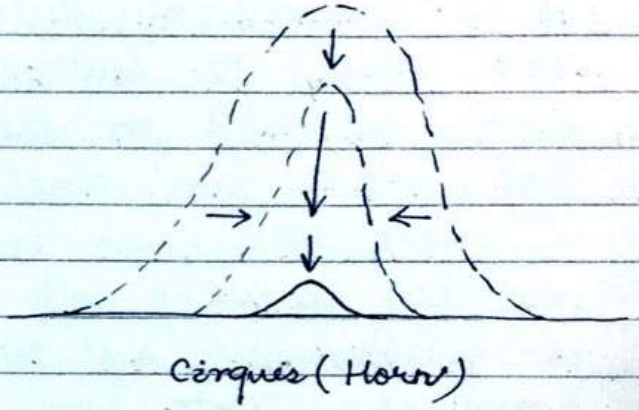
this stage, continuation of weak horizontal abrasion
ñ dominating deposition creates the general hillslope
ms to be concave with maximum of elevation eroded
d maximum of depression filled. This concave hillslope
m, however, marks the potentiality of presence of remnants
wex elements depicting the role of geological structure.
s approach of slope decline at par with normal cycle
erosion due to its simplicity makes it the most
owed ideological school with all the major geomorphologist
loving this school of thought.

ope Replacement Theory The slight deviative approach which is
o significantly followed is the slope replacement theory
Penck. Unlike his morphological system, Penck could
erate slope replacement as "well defined theory" counter-
ancing Davisian ideological school. He developed his
broach in presuming the presence of homogenous structural cliffs
h non-eroding, non-depositing river at its foot. With
x pre-assumed condition, he idealised the approach of
be replacement; where homogenous weathering of the
jected cliff, mass wasting of the material will be
ntinuously transported by the effective river at the foot;
using slope replacement and converting the landscape from
eface slope form to concave form.

s theoritical orientation of Penck, wher, is practically
pplied, it depicts its validity in the functioning of sea waves
s an active agent of gradation as well as Alpine
aciers. In the case of sea waves, the retreat of
a cliff excellently depicts slope replacement applicable
ly on one side which marks the conversion of

hillslope form either from convex or freeface to concave form as wave-cut platform. Similarly when we this approach is applied to more than one side of the slope the basal sapping effect carried on by Alpine glaciers in generating horn topography. In this topography, parallel retreat of the hillslope can convert the hillslope from convex to concave form depicting collapse of horn in the old stage of glacial cycle.





Channel Morphology → (Running Water as active agent) + (Drainage Pattern)

Will be covered later.

Lecture # 18

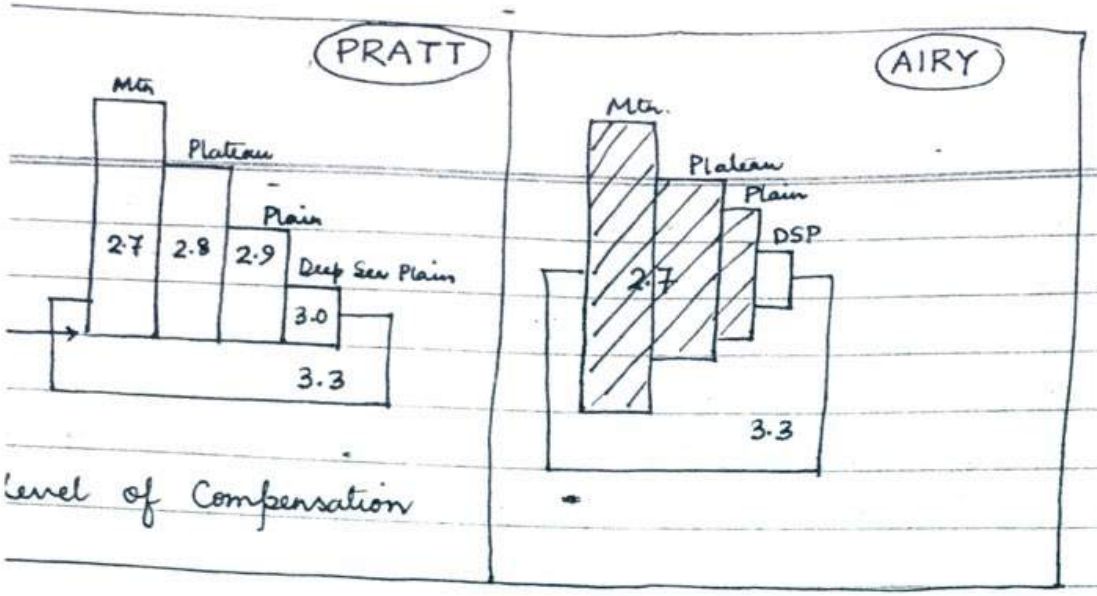
03/2014

ISOSTASY

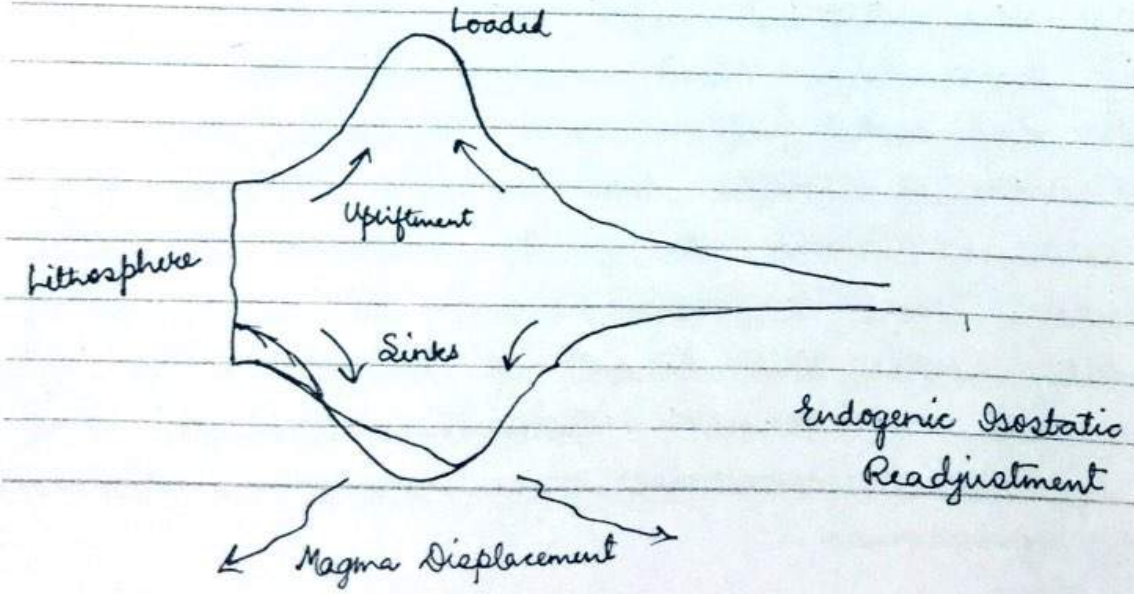
stasy is the concept of equilibrium that is prevalent b/w
structure lithospheric features irrespective of their height &
th on the fast spinning Earth. The genesis of this
roach in the former lines is traced back to first half
19th century when Sir George Everest attempted the
graphical surveys in order to determine structure of
malayan mountains. Utilising 2 different methods i.e.
round surveying and remote platform survey, he concluded
fferent record of distance b/w the same 2 centres
ated along the Southern slopes of Himalayas. Greater
tance calculated on the reference of ground survey
thod made him conclude that as Himalayas are pulling
ir mass, there has been a deflection caused in the
mp bob resulting into the development of greater distance.
is establishement by Sir G. Everest was further carried
ward by Pratt who became one of the significant
pounder of approach in isostasy. In his study, Pratt
ncluded that if Himalayas would have been actually
ting the mass projected for its size & height, the differena
the distance b/w the 2 places by Sir G. Everest would
e been more than 3 times than actually calculated. This
alysis made him conclude that "Himalayas are not
ting its projected mass" as it is made up of lighter
sity rocks. It is this conclusion that made him propound
ological school of isostasy that is called "Different
sities and Same Depth". This ideological school popularly
own as "Level of Compensation Concept"; projects that
ller features are made up of lighter density rocks
nd deep seated features - denser rocks. It is, therefore,
at they mark the equilibrium or balance on the

fast spinning Earth. In accordance to his approach all the differences of density gets compensated at the specific level of aesthenosphere called "Level of Compensation". His analysis established one of the most referred ideological school in the geomorphic studies. It is followed on by big range of contributors to the study of isostasy specifically Hayford & Bowie. It is his analysis that led to the establishment of equilibrium study that was given the name isostasy by Dutton, who explained it to be "The concept of floating crust in gravitational balance".

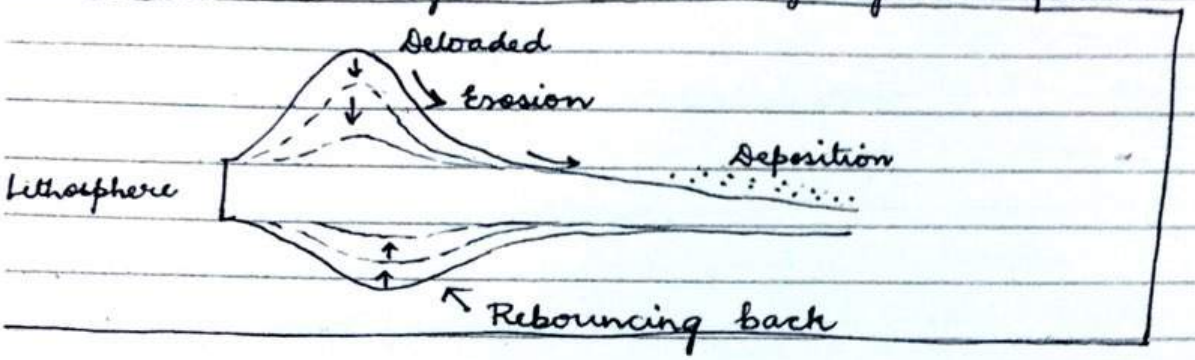
Pratt's level of compensation excellently explains the cause of equilibrium b/w the features of continent crust (granitic lighter density) and oceanic crust (basaltic denser). However, when the approach is applied to the individual crustal features, it avails the faulty description of variable density. It is this aspect of limitation that led to the development of mountain root concept of Airy, that makes the 2nd ideological school in the study of isostasy. Airy's approach emphasizes on "similar density" and variable depths" i.e. all the lithospheric features are projected to be made up of same density rocks. They mark equilibrium because they have different sizes in accordance to which taller features have deeper roots which makes them in balance with deep seated features with Shallower roots. This established school of thought best explains: "Intra-crustal features", However, avails the faulty description in identifying that continental crust & oceanic crust are made up of same density rocks. This school of thought is strongly contributed by HEISKANEN. Both these ideologies are taken to be "COMPLIMENTING EACH OTHER" in describing Isostasy or equilibrium.



PRACTICALLY, isostasy or the floating crust in gravitational balance continuously experiences interruptions by the geomorphic and climatic factors. Geomorphologically, both endogenic forces and exogenic forces induces modifications to persisting eqmb. the effect of endogenic forces, development of variation it is increase in the absolute height results in: "Loading the Crust" i.e isostasy is interrupted and in order to maintain the floatage, every upliftment resulting in the sinking of the crust not just generate "mountain roots" but also causes "displacement of magma" in aesthenosphere beneath the mountain root to sustain the floatage. This upliftment called isostatic rebouncing is applicable to all the locations where endogenic upliftment dominates.



by the effect of exogenic forces, the induced levelling effect deloads the crust. This makes isostasy interrupted with simultaneous readjustment caused by rebouncing of deloaded crust and thus the termination of displacement of magma from underneath mountain root. This type of readjustment are applied to be more practical with ancient relief where the levelling task is majorly completed.



Climatologically isostasy marks its interruptions and readjustments in terms of ice age and its termination. During ice age loaded continental crust registers sink and thus, magma displacement in aesthenosphere in ~~ot~~ order to sustain isostatic balance. However, after iceage deloaded continental crust registers rebouncing to regenerate isostatic balance simultaneous to the loaded oceanic crust registering sink and thus magma displacement in aesthenosphere underneath it. It is post ice-age isostatic readjustment that is making Scandinivian shoreline continuously becoming shallower restricting commerciall potentiality of the developed sea-ports.