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By Ankit Agarwal sir (Scored 356 Marks)

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Erosional Surfaces

GEOGRAPHY-PAPER-1
SECTION-A
GEOMORPHOLOGY

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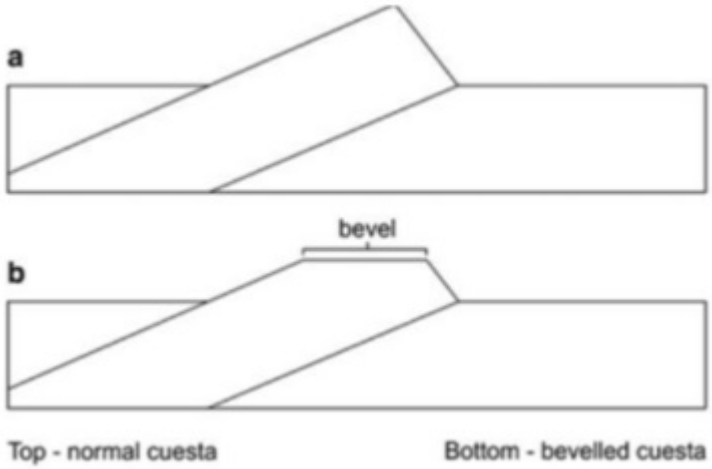
- The topographic evolved surface having undulating ground surface and remnant of high relief, which is the ultimate output of the denudation processes and cutting across geological formation and structures is generally called **erosion or planation surface.**
- In general, **erosion surface is described as the geographical plain surface, which is the product of complete or incomplete cycle of erosion** (Gilbert 1877).
- **Many Scholars have described the planation surface in different words such as 'Peneplain' (Davis) 'Pediplain' (L.C.King), 'Panplain' (Crickmay), 'Etchplain' (Wayland 1934, Thomas), Panfan (A.C. Lawson), Primarrumpf, Gipfelflur, Stockwerk, Schietelflur and 'stripped surface' (Budel 1957)**. Besides there are some minor erosion surfaces like **valley side beaches (terraces)**, **river terraces, marine benches (platform), etc.**
- **Erosion surface is important in the evolution of landform**. It is useful to understand the geomorphic processes acting on the land surface in the past and the evolutionary history of the landscape. It is useful to understand the denudation chronology.
- Denudation chronologists once eagerly sought erosion surfaces. However, the search for erosion surfaces became unfashionable, particularly in British geomorphological circles, during the second half of the twentieth century, with many geomorphologists questioning their existence.
- The current consensus is that they do exist, and a revival of interest in them is apparent. As Ollier (1981) not so tactfully put it, 'most people who are not blind or stupid can tell when they are in an area of the relatively flat country: they can recognize a plain when they see one'. Of course, a plain may be depositional, constructed from successive layers of alluvial, lacustrine, marine, or other sediments.

Erosional plains that cut across diverse bedrock types and geological structures are all planation surfaces of some kind. They occur in low-lying areas and at elevation. Elevated plains sometimes bear signs of an erosional origin followed by subsequent dissection. A good example

is a **bevelled cuesta**. Here, the flat top or bevel on a cuesta is credible evidence that an upper erosion surface, sitting at about the level of the bevel, existed before differential erosion moulded the cuesta. A word of warning is in order here: one bevelled cuesta does not a planation surface make. An isolated bevel might have been a river terrace or some other small flat feature. Only when many bevelled cuestas occur, with the bevels all at about the same elevation, does the former existence of a planation surface seem likely.

- **A cuesta is a hill or ridge with a gentle slope on one side, and a steep slope on the other**
- Planation or erosional surfaces (paleoplain) are the end product or near end product of the processes of different agents of erosion, like wind, running water, glacier etc., in different climatic regions (humid, arid). It has been defined by **Gilbert** as the '**Process of carrying away the rock so as to produce an even surface and at the same time covering it with an alluvial deposit**'. These geographically plain surface or faint relief is produced in the last phase of cycle of erosion.



Peneplains

- The concept of a peneplain (the word meaning —almost a plain) **emerged from W.M. Davis'cyclic view of landscape evolution.**
- As rivers and hillslopes reduced relief through the phases of youth, maturity, and old age, explained Davis, the eventual result was a **plain of extremely low**

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relief. This plain could only change very slowly since potential energy for fluvial action was greatly reduced.

- Valleys are thought to be V-shaped in youth, flat bottomed in maturity, after lateral erosion has become dominant, and to possess very shallow features of extensive plains in old age, after lateral erosion has removed all hills.
- Young landscapes are characterized by much flat topography of the original uplifted peneplain. Mature landscapes have deeper and wider V-shaped valleys that have consumed much of the interfluves bearing remnants of the original land surface. **Old landscapes are characterized by a peneplain, in which the interfluves are reduced to minor undulations.**

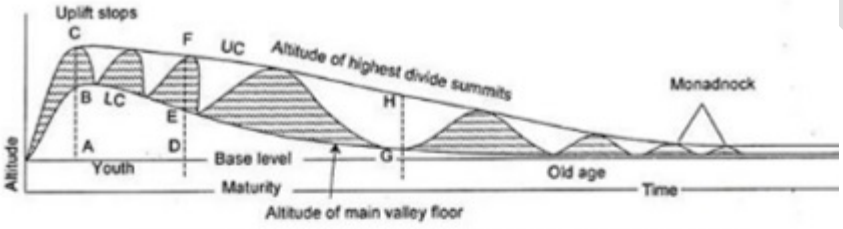
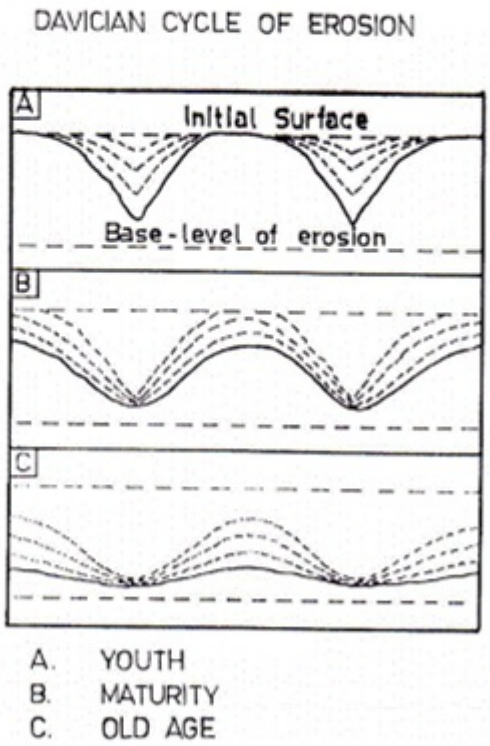


Fig. 16.1 : Graphical presentation of geographical cycle presented by W.M. Davis.



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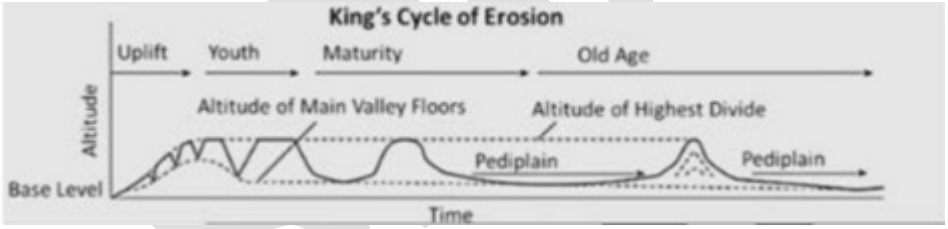
Pediplains

- Penck's model of slope retreat was adopted by **Lester Charles King**, **who, in another model of landscape evolution, proposed that slope retreat produces pediments and that, where enough pediments form**, a pediplain results (King 1953, 1967, 1983). King envisaged '**cycles of pedimentation'.**

  Each cycle starts with a sudden burst of cymatogenic diastrophism and passes into a period of diastrophic quiescence, during which subaerial processes reduce the relief to a pediplain. As a continent is denuded, so the eroded sediment is deposited offshore. With some sediment removed, the continental margins rise. At the same time, the weight of sediment in off-shore regions causes depression.
- The concurrent uplift and depression institutes the development of a major scarp near the coast that cuts back inland. As the scarp retreats, leaving a pediplain in its wake, it further unloads the continent and places an extra load of sediment offshore.
- Eventually, a fresh bout of uplift and depression will produce a new scarp. Thus, because of the cyclical relationship between continental unloading and the offshore loading, continental landscapes come to consist of a huge staircase of erosion surfaces (pediplains), the oldest steps of which occur well inland.



Endrumpf

- In the model of landscape evolution **proposed by Walther Penck**, the final stage of erosion that follows the disappearance of inselbergs and the pediments surrounding them. The **endrumpf is a landscape of low-angle, concave slopes that are slowly retreating.**
- A variation on Davis's scheme was offered by Walther Penck. **For the end product of cycle of erosion, he used the term Endrumpf with isolated features of inselbergs**.

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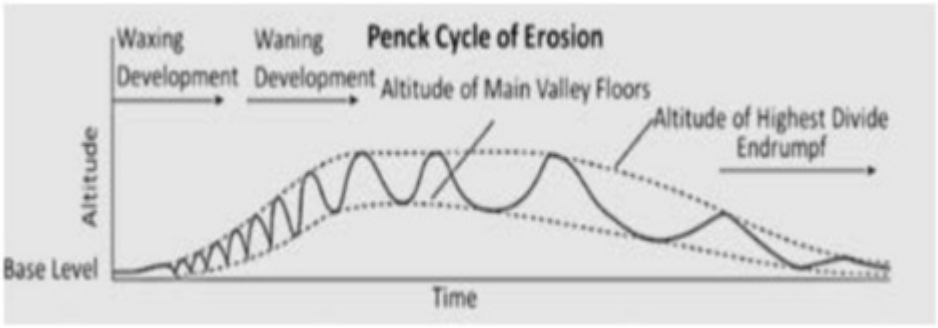
- According to the Davisian model, uplift and planation take place alternately. But, in many landscapes, uplift and denudation occur at the same time. The continuous and gradual interaction of tectonic processes and denudation leads to a different model of landscape evolution, in which the evolution of individual slopes is thought to determine the evolution of the entire landscape (Penck 1924, 1953).



Panplains

- Another variation on slope retreat concerns the **notion of unequal activity espoused by Colin Hayter Crickmay** (1933, 1975). Davis's, Penck's, and King's models of landscape evolution assume that slope processes act evenly on individual slopes. However, geomorphic agents act unequally.
- For this reason, a slope may recede only where a stream (or the sea) erodes its base. If this should be so, then slope denudation is largely achieved by the lateral corrasion of rivers (or marine erosion at a cliff foot). This will mean that **some parts of the landscape will stay virtually untouched by slope recession. Crickmay opined that lateral planation by rivers creates Panplains.**

Etchplains and Etched Surfaces

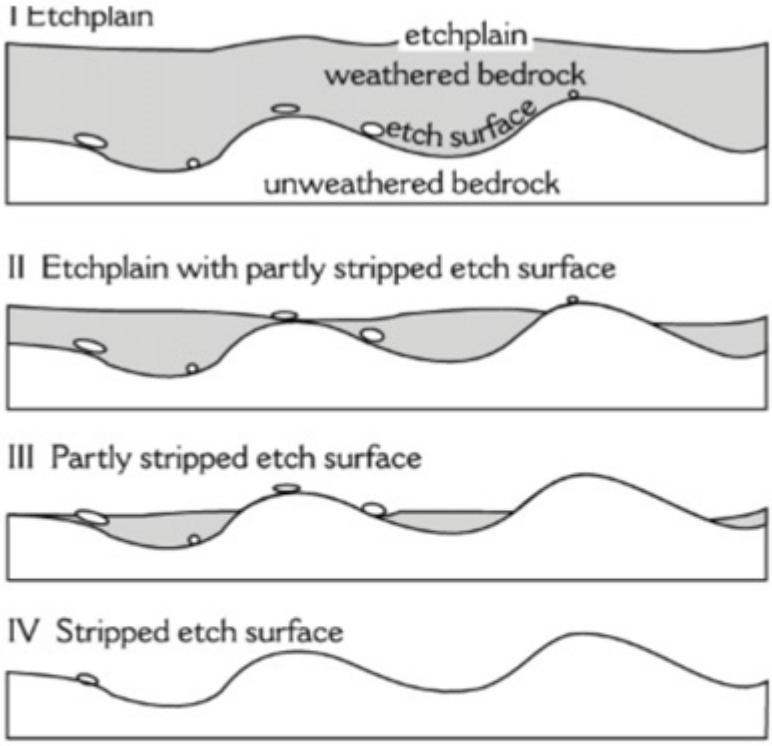
- Traditional models of landscape evolution assumed that **mechanical erosion predominates**. **It was realized that chemical weathering reduces the mass of weathered material, but only on rocks especially vulnerable to solution (such as limestones) were chemical processes thought to have an overriding influence on landscape evolution**. However, it now seems that forms of chemical weathering are important in the evolution of landscapes. Groundwater sapping, for instance, shapes the features of some

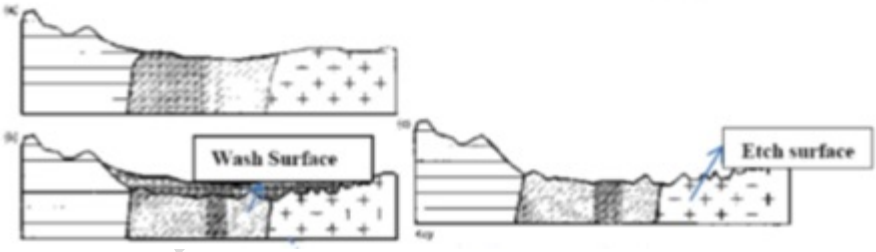
drainage basins. Some geomorphologists suspect that chemical weathering plays a starring role in the evolution of nearly all landscapes.

- **In tropical and subtropical environments, chemical weathering produces a thick regolith that erosion then strips. This process is called etch planation.**
- **It creates an etched plain or etchplain**. The term **'etchplain' or 'etched peneplain' was originally coined to describe surfaces in East Africa by E.J. Wayland in 1933 and Bailey Willis in 1936**.
- Julius Budel developed the concept further in the second half of the 20th century.
- The **etchplain is largely a production of chemical weathering**. In places where the regolith is deeper, weakly acid water lowers the weathering front, in the same way that an acid-soaked sponge would etch a metal surface. Some researchers contend that surface erosion lowers the land surface at the same rate that chemical etching lowers the weathering front. This is the theory of double planation. It envisages land surfaces of low relief being maintained during prolonged, slow uplift by the continuous lowering of double planation surfaces – the wash surface and the basal weathering surface (etch surface).
- **Thomas suggested that there may be several types of etchplains ranging from the stripped etchplain to those erosion surfaces which are covered with thick waste.** Various parts of Chotanagpur represent one type of etchplain. Here the bedrock is mostly concealed by a thick layer of soil and regolith. At the surface of the waste, there are beds of laterite which serve as a sort of cap rock and help in the maintenance of even topography. Rivers may or may not dig up to the bedrock. There may be residuals projecting above the layer of waste.
- **Thomas has illustrated five types of etchplains** –
  undissected lateritized surface;
  dissected lateralized etchplain,
  extensively stripped surface,
  partially stripped erosion surface and
  incised erosion surface.

There may be several other variants like the one represented by Chotanagpur.

- **Etchplain may apply to surfaces developed on non-crystalline sedimentary rocks**. Some still doubt the distinction of etchplains from pediments. Thomas feels, however, that the term may be retained. This may be due to the special connotation attached to the term particularly by such geomorphologists as Wayland. Moreover, it might help explain the miscellaneous items of the former surfaces of warmer climates now found in temperate latitudes.





Panfan

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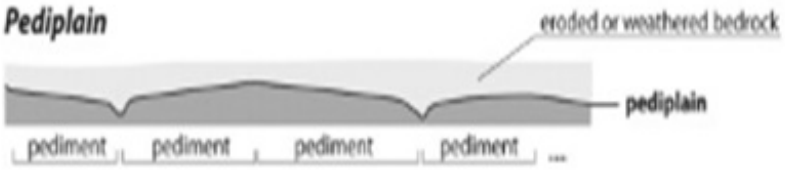
- **Lawson used the term Panfan to designate the termination of the state of geomorphic development in an arid region** in the same way the peneplain is found at the end stage of the general process of degradation in a humid region.



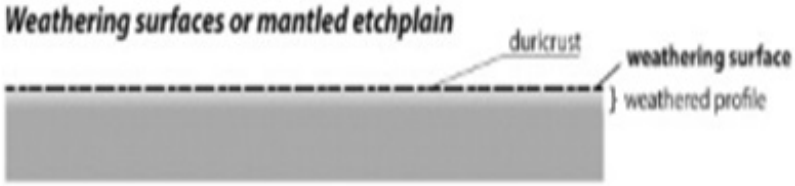


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Table Types of palaeoplain

Landform or surface	Definition	References
Defined by genesis and appearance		
Erosion surface	A surface formed by removal of material through agents of erosion (glaciers, rivers, sea, wind), but not mass movements or weathering	Adams (1975)
Denudation surface	A surface created by denudational processes – weathering plus erosion (the weathering is crucial as it renders the bedrock removable)	Lidmar-Bergström (1988)
Peneplain	An almost featureless surface of low relief, in which occasional residual hills (monadnocks) may occur. Forms through the down-wearing of slopes to baselevel (sea level) after a bout of uplift	Davis (1899)
Pediplain	A flat area of low relief at the foot of an elevated feature, such as a hill or a mountain), occasionally broken up by residual hills (inselberge). Forms as the end-product of a landscape fashioned by parallel slope retreat	Penck (1924)
Panplain	A broad and level surface fashioned by lateral corrasion of rivers leading to the coalescence of adjacent floodplains	Crickmay (1933, 1975)
Etch surface	A surface at the interface between weathered saprolite and unweathered bedrock	Büdel (1982), Thomas (1974, 1994)
Etchplain	A flattish surface created in tropical and subtropical environments when chemical weathering produces a thick regolith that erosion then strips	Thomas (1989a, 1989b)
Exhumed surface	A surface covered by, for example, Palaeozoic or Mesozoic cover rocks and later successively uncovered (exhumed)	Lidmar-Bergström (1988, 1996)
Defined by appearance		
Planation surface	'Land surfaces modelled by surface or near-surface wear on a rock mass, where the result of the wear is reasonably plane (planate)'	Adams (1975)
Defined by ancient age and preservation to the present		
Palaeosurface	'an identifiable topographic surface of either endogenic or exogenic origin . . . of demonstrable antiquity, which is, or was originally, of regional significance, and which as a consequence of its evolution, displays the effects of surface alteration resulting from a prolonged period of weathering, erosion, or non-deposition'	Widdowson (1997)

Source: Adapted from Ebert (2009a)

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References: S.Singh and P.Dayal

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