Geography Foundation

25/Sep/24

Geomorphology

12:00 - 2:20 | Lec 19

Denudation Chronology & Erosional surfaces

- DC and Erosional surface as a concepts are relevant to Historical Approaches to slopes & land forms studies.
- The concepts were developed & used extensively in British school of Geomorphology
- Davis adopted this technique while developing Model of Cycle of Erosion.
- Land forms are identified, there age is determined & are interpreted in sequence of which land form has followed & preceded which land forms.
- Every Region on a desirable scale can be studied through Denudation Chronology

Ex For India - 3 major Tectonic Divisions arranged in terms of their age is India's Denudation Chronology

DC of India

Oldest - ① Peninsular Plateau (> 2bn years old)
- E. Ghats
- Aravallis
- Vindhyan Range

② Himalayas (60my old)
- Karakoram
- Great Himalayas
- Middle Himalayas
- Shiwalik

Youngest ③ N. Plains (2-2.5my old)

- DC is based on study of very old Erosional surfaces which preserves the imprints of past processes
- ★ Erosion surface in Historical school of Geomorphology is not any Erosion feature
- Erosion surfaces are also referred to as Palimpsest Topographies. (Palm leaf Manuscripts - that preserve the efficiencies of past Erosional Process which help in reconstruct

of Geological History of a Place

- The following are characteristics of ideal Erosional surfaces -

1] They are very large & extensive surfaces

2] They are relatively flat

3] They are at or near Base Level

4] They will not have Relief variations because of relative difference of Rock hardness

- Some of examples of good Erosion surfaces are -

- Peneplains
- Pediments
- Etchplains → Because of Chemical weathering & flattening (formed commonly in savannah region)
  → This idea was given by Pug & Thomas
- Convoplains
- Pappplains

→ Given by Bailey, Erosion & weathering in Peni Glacial conditions. (Process - Alluviation, Convolution)

- Panplains – flat plains formed by River erosion where River divides, narrow down & erosion flat plains expand. This idea was given by Cuickmay.

* Erosional surface is also an example of palimpsest Topography.

- However, in reality, Erosion surfaces are highly modified. they can get uplifted & found at higher heights, they can get overlain by sediments or they can get submerged under sea.

- Many Erosion surfaces get destroyed by subsequent cycle of Erosion.

- Since the Pleistocene Glaciation or Pleistocene Ice age, many E.s has been destroyed by powerful glacial process

- This implies Pre-Quaternary land forms are very few properly preserved. Reconstructing earth's Geological history based on very few

E.S is a highly subjective exercise & will have flaws of extreme Deductive Reasoning

Deductive Reasoning

- Study few instances → Make General statements
  - Study specific
  - Make Laws → check for specific studies)
- Speculative Generalisations which may not be right.
- Laws → check instances
- General → Particular

Inductive Reasoning

- Study specifics → make General statements
- All instances → then make Laws.
- Particular → General

* Reference - pg 308 | Chapter 17 (Geomorphology by SJ)
  ↳ DC
  pg 309 - Erosional surfaces

- The above challenges makes study of E.s a very subjective exercise. because E.s are modified, are destroyed, are inaccessible and it is difficult to ascertain age of Erosional surfaces.
- Hence, Historical Approach in landform study in general is a speculative (not a very suitable technique
- The above discussion can be added to criticism of Davisian Model

Technique of Identifying Erosional surfaces

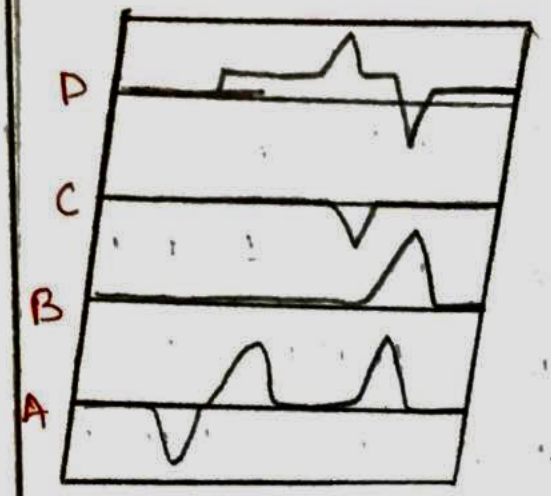
1] On field, experience based Landscape evaluation

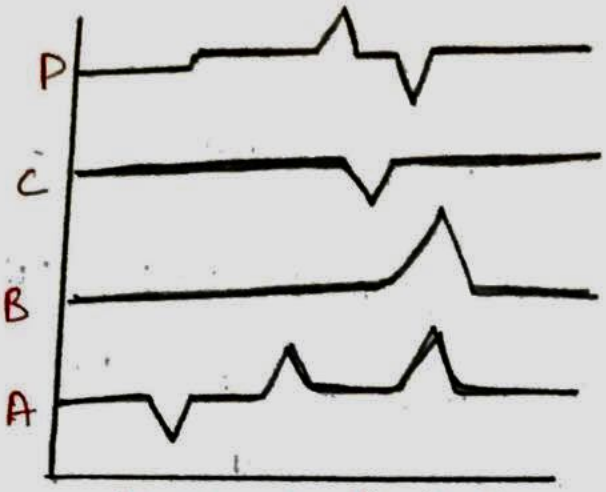
2] Techniques of Rock dating - Carbon Dating Techniques or also Non Radio activity based Techniques [study of stream order, study of stream spacing] & Techniques of Relative dating such as superimposed Dating Technique

3] Statistical Techniques - study of spot heights frequency or study of spot height altimetric graphs

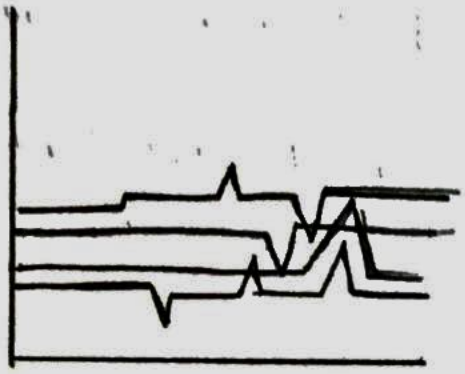
4] The spot height technique is based on the principle that if there is an Erosion surface that may have been modified there is every likelihood that there are more instances that certain height will be repeated most frequently even if landscape has lot of height variation. This can be plotted on Frequency Graphs or Histograms for E.g identification

Reference pg 331 (Geomorphology by SJ)

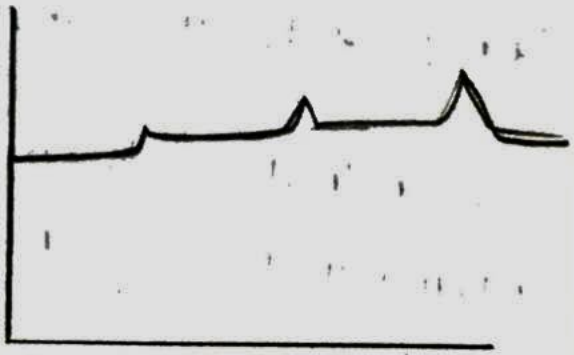




(a) Serial Profile



(b) Super Imposed Profile



(c) Composite Profile
(Topmost elevated portion of all profiles)

(d) Projected Profile

Fig Profile Techniques

Reference - pg 312 - Profile Techniques (Thomas Phillips by SJ)

4] Erosion surfaces can also be identified by studying landscape cross section or profile (Profile study is a good way of identifying relative flatness of an area)

- There are four ways of depicting profile-

a] Serial Profile- Cross section lines are shown in diff. graphs

b] Superimposed Profiles- Profile lines are overlap on a single graph

c] Projected Profiles - Land forms in front are shown & higher ones behind can be shown but not lower land forms behind higher ones

d] Composite Profile - only a highest points are shown like a skyline.

(Diagram- In previous page)

Channel Morphology -

- River & stream study

(a) How does river decide & forms what land forms
- Ex valleys, deltas etc
- All rivers

(b) Davis Model
- River creates land forms = f(stage)
- River Model

(c) Channel Morphology
- Relationship b/w River works, cross section of River valley & associated land forms
- study very specific rivers.

Channel Morphology :-

- Channel Morphology is a detailed study of a single river & studying relationship b/w-

a] Channel Hydrology (Hydraulics) (Amount & Discharge of water & water velocities)

- These studies have lot of Mathematical approach

b] Hydraulic Geometry (Depth of River, Width of valley, Wetted Perimeter)

c] Geomaterial & Channel Land forms (Type of rocks, Amount of sediments & what land forms are formed.

- Channel Morphology studies are very specific to a particular river & using Morphology studies, they can be actual River planning for Construct flood Management & study of River shifting & consequences

(Channel Morphology has an Applied Aspect)

- There are diff. aspects on studies of Channel Morphology :-

a] Relationship of Discharge (Q) with (Volume / Time)

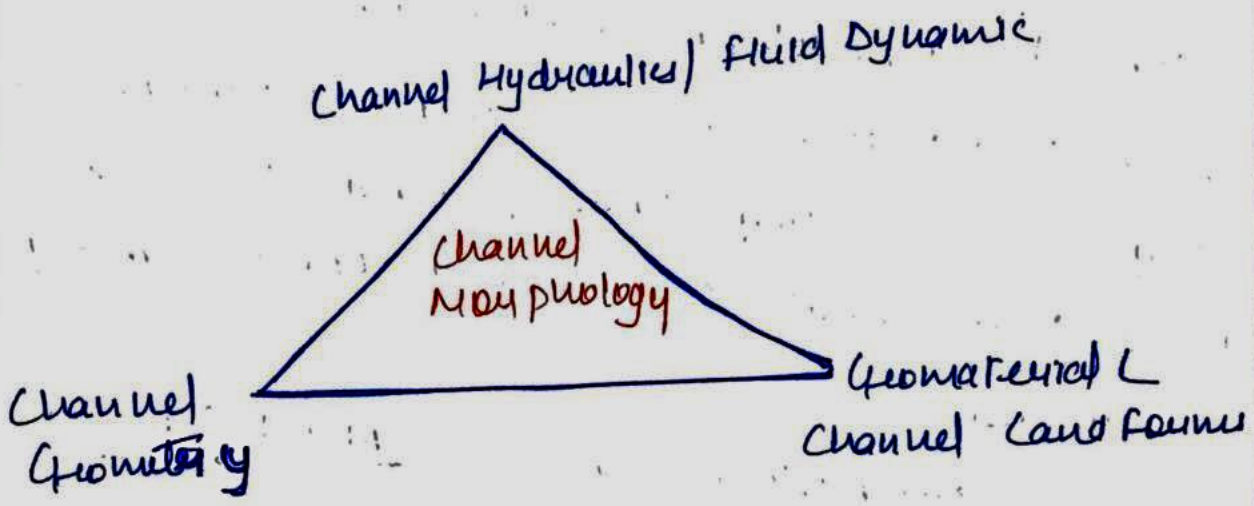
River Velocity, Depth & Width of River)

b] Relationship of River Velocity with Sediments

c] Study of River Meandering

d] Study of Types of channels

- based on nature of rocks or sediments through which river flows
- on basis of relative meandering



Denudation Chronology & Erosion surface

PYQs

Que State concept of Erosion surfaces and highlight the factors responsible for their development (2014) (15M)

Que Discuss problems of Erosional surfaces & explain diff. methods to identify them with suitable diagrams (2020) (20M)

Que Describe concept of Altiplanation (2021) (10M)

4. Discuss the problems of erosional surfaces and explain the different methods to identify them with suitable diagrams. [Q40 Optional] [2020] [20M]

Ans4. The almost plain topographic surfaces having undulating surface and low remnant relief features. These low relief features and almost plain surface are result of long term denudational processes. These surfaces are also known as planation surfaces for eg. Peneplain, pediplain, panplain and etch plain etc.

Problems Of Erosional Surfaces are as follows:

- **Problems of identification of erosional surfaces**
  - Identification can be challenging due to their **subtle nature**, **geological complexity, overprinting by deposition**, **tectonic deformation**, **diagenetic changes**, spatial and temporal variability, and **data limitations**.
  - Geologists overcome these challenges through careful field observations, **sedimentological analysis**, **stratigraphic correlation**, **geophysical techniques**, and integration of multiple lines of evidence.

- **Problems because erosional surfaces younger than tertiary era are not found**
  - Erosional surfaces younger than the Tertiary era are not commonly found due to factors such as **burial by sedimentation**, **erasure by ongoing geological processes**, limited exposure, **intense tectonic activity**, **incomplete geological records**, and **data limitations**.
  - Erosional surfaces that are older than the tertiary period have undergone deformation in terms of **sedimentation**, **denudation** as well as tectonic upheavals thus it is very difficult to identify these surfaces and if identified then to study the geological features of these surfaces.

- **Problems in dating of erosional surfaces**
  - Dating of erosional surfaces is done based on the principle of geological unconformity according to this principle, surfaces that are above are relatively older than the surfaces above. However sometimes due to tectonic processes and sediment removal the older surfaces are resurrected and are placed above the young surfaces making dating of erosional surfaces difficult.

Different Methods To Identify Erosional Surfaces Are As Follows:

- **Stratigraphic Analysis** which is carried out by comparing sedimentary layers above and below a potential erosional surface can reveal abrupt changes in lithology, bedding characteristics, or fossil content, indicating erosion and subsequent deposition.

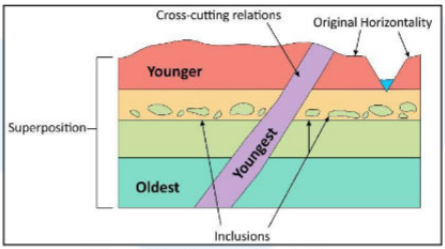


Figure: Stratigraphic Analysis

- **Geomorphic Mapping** is done by mapping surface features such as valleys, terraces, or unconformities that can help identify erosional surfaces. Different erosional processes leave distinct landforms which aids in their recognition.

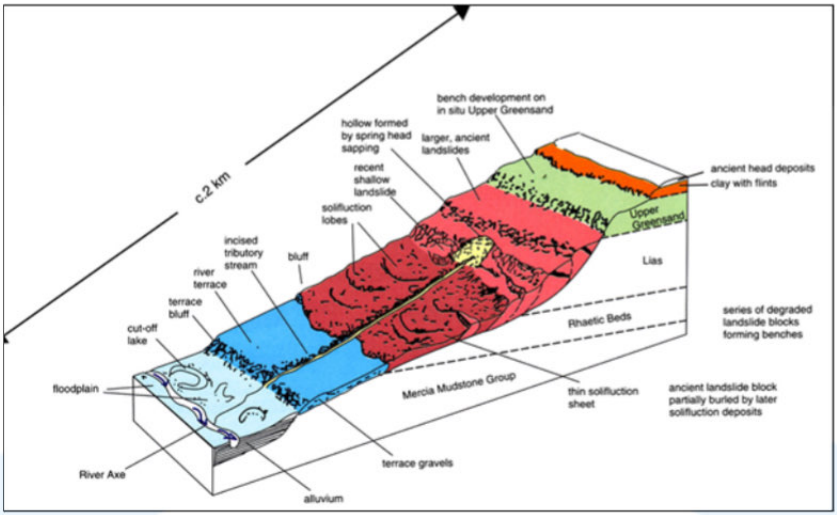


Figure: Geomorphic Analysis

- **Paleontological and Petrological Methods** are undertaken by examining fossils or minerals within sedimentary layers can provide clues about interruptions in deposition, suggesting erosional events. Changes in fossil assemblages or rock types can indicate presence of erosional surfaces.

- **Geophysical Techniques** utilize geophysical methods like **ground-penetrating radar** (GPR), **seismic surveys**, or **electrical resistivity tomography** (ERT) and can help in detecting subsurface erosional features, aiding in their identification.

- **Chronostratigraphy** is done by establishing absolute or relative ages of sedimentary layers using radiometric dating or stratigraphic correlation this can help identify erosional surfaces by identifying gaps in the geological record.

Identifying erosional surfaces is crucial for understanding Earth's geological history. Despite challenges methods like stratigraphic analysis, geomorphic mapping, and geophysical techniques help geologists recognize these features. Integration of multiple methods provides insights into past environmental conditions and landscape evolution.

Question 1: Describe the concept of 'Altiplanation'. 10 marks [Geo Optional] [2021]

Answer

Introduction:

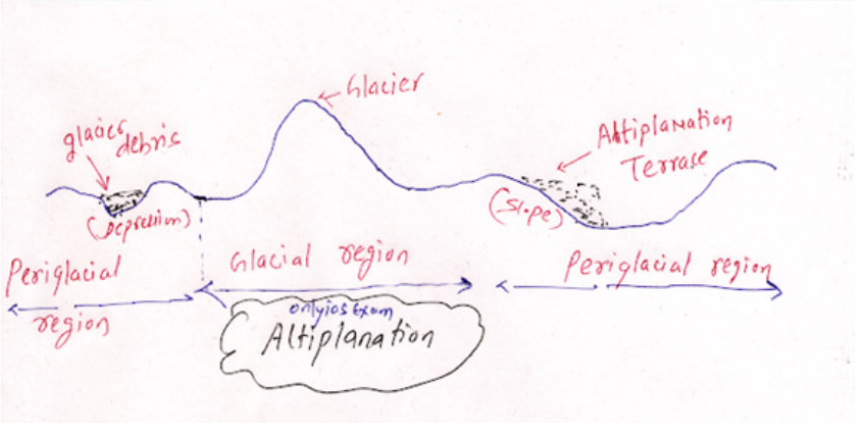
Altiplanation, also referred to as equi-plantation or cryo-planation, is a geological process involving land leveling in high-altitude peri-glacial regions. These areas, situated near glaciers, witness distinctive landscape modifications influenced by glacial activity.

Body:

Concept of Altiplanation:

Altiplanation is the process of land leveling in periglacial regions. It involves the deposition of moraines, debris carried by glaciers, either in depressions or on slopes, creating altiplanation terraces.

The term was coined by Eakin in 1916, with variations like equi-plantation and cryo-planation used by Cairnes and Bryan, respectively.



Detailed Process of Altiplanation:

- Glacial Transport: Glaciers transport eroded material (moraines) and deposit them.
- Terrace Formation: Moraines accumulate in depressions or on slopes, forming altiplanation terraces.
- Cryogenic Processes: Cryo-planation emphasizes the impact of cryogenic processes on land leveling in periglacial regions.
- Leveling through Erosion: Besides deposition, land leveling also occurs through erosion processes.

Examples:

- Himalayan Region: Altiplanation is observed in the Himalayas, where glacial activity contributes to the formation of altiplanation terraces.
- Andes Mountains: Similar land-leveling processes shape the landscape in the high-altitude Andes region.

Conclusion:

Altiplanation, with its distinctive features in high-altitude peri-glacial areas, plays a crucial role in shaping landscapes. Understanding this process aids in comprehending geological changes. As our understanding of these processes evolves, further research can enhance predictive models for landscape evolution and contribute to sustainable land use planning in such regions.