

## Chapter -6

# Geomorphic Processes

- **Landslides:** These are relatively rapid and perceptible movements. The materials involved are relatively dry. The size and shape of the detached mass depends on the nature of discontinuities in the rock, the degree of weathering and the steepness of the slope.
- **Gradation:** The phenomenon of wearing down of relief variations of the surface of the earth through erosion is known as gradation.
- **Geomorphic processes:** The endogenic and exogenic forces causing physical stresses and chemical actions on earth materials and bringing about changes in the configuration of the surface of the earth are known as geomorphic processes.
- **Exogenic forces:** The external forces are known as exogenic forces. These forces derive their energy from atmosphere determined by the ultimate energy from the sun and also the gradients created by tectonic factors.
- **Endogenic forces:** The internal forces are known as endogenic forces.
- **Geomorphic agents:** An agent is a mobile medium (like running water, moving ice masses, wind, waves and currents etc.) which removes, transports and deposits earth materials. Running water, groundwater, glaciers, wind, waves and currents, etc., can be called geomorphic agents.
- **Diastrophism:** All processes that move, elevate or build up portions of the earth's crust come under diastrophism.

- **Orogepy:** It is a mountain building process
- **Epeirogeny:** It is continental building process.
- **Volcanism:** Volcanism includes the movement of molten rock called magma onto or toward the earth's surface and also formation of many intrusive and extrusive volcanic forms.
- **Stress:** Gravitational force acts upon all earth materials having a sloping surface and tend to produce movement of matter in down slope direction. Force applied per unit area is called stress.
- **Weathering:** Weathering is defined as mechanical disintegration and chemical decomposition of rocks through the actions of various elements of weather and climate
- **Denudation:** The term 'denude' means to strip off or to uncover. Weathering, mass wasting/ movements, erosion and transportation are included in denudation.
- **Solution:** When something is dissolved in water or acids, the water or acid with dissolved contents is called solution.
- **Carbonation:** Carbonation is the reaction of carbonate and bicarbonate with minerals and is a common process helping the breaking down of feldspars and carbonate minerals.
- **Hydration:** Hydration is the chemical addition of water.
- **Structure:** The term structure includes such aspects of rocks as folds, faults, orientation and inclination of beds, presence or absence of joints, bedding planes, hardness or softness of constituent minerals, chemical susceptibility of mineral constituents; the permeability or impermeability etc. ,

- **Enrichment:** When rocks undergo weathering, some materials are removed through chemical or physical leaching by groundwater and thereby the concentration of valuable materials increases. It makes the concentration of the same valuable material sufficient and economically viable to be exploited, processed and refined. This is called enrichment.
- **Debris Slide:** Rapid rolling or sliding of earth debris without backward rotation of mass is known as debris slide. • **Erosion:** The erosion can be defined as "application of the kinetic energy associated with the agent to the surface of the land along which it moves".
- **Soil:** A pedologist who studies soils defines soil as a collection of natural bodies on the earth's surface containing living and/or dead matter and supporting or capable of supporting plants. Soil is a dynamic medium in which many chemical, physical and biological activities go on constantly.
- **Deposition:** The erosional agents lose their velocity and hence energy on gentler slopes and the materials carried by them start to settle themselves. Therefore, deposition is not actually the work of any agent. The coarser materials get deposited first and finer ones later. By deposition depressions get filled up
- **Slump:** Slump is slipping of one or several units of rock debris with a backward rotation with respect to the slope over which the movement takes place.
- **Pedology:** It is soil science.
- **Pedologist:** A pedologist is a soil-scientist.
- **Parent Material:** Parent material is a passive control factor in soil formation.

- **Earth Flow:** Movement of water-saturated clayey or silty earth materials down low-angle terraces or hillsides is known as earth flow.
- **Nitrogen Fixation:** Humus accumulates in cold climates as bacterial growth is slow. With undecomposed organic matter because of low bacterial activity, layers of peat develop in sub-arctic and tundra climates. In humid tropical and equatorial climates, bacterial growth and action is intense and dead vegetation is rapidly oxidised leaving very low humus content in the soil. Further, bacteria and other soil organisms take gaseous nitrogen from the air and convert it into a chemical form that can be used by plants. This process is known as nitrogen fixation.
- **Desilication:** Removal of silica from the soil is known as desilication. • **Exfoliation:** It is a result but not a process. Flaking off of more or less curved sheets of shells from over rocks or bedrock results in smooth and rounded surfaces is called exfoliation
- **Exfoliation domes:** Large, smooth rounded domes are called exfoliation domes.
- **Tors:** In rocks like granites, smooth surfaced and rounded small to big boulders form due to such exfoliation. It is called tors.

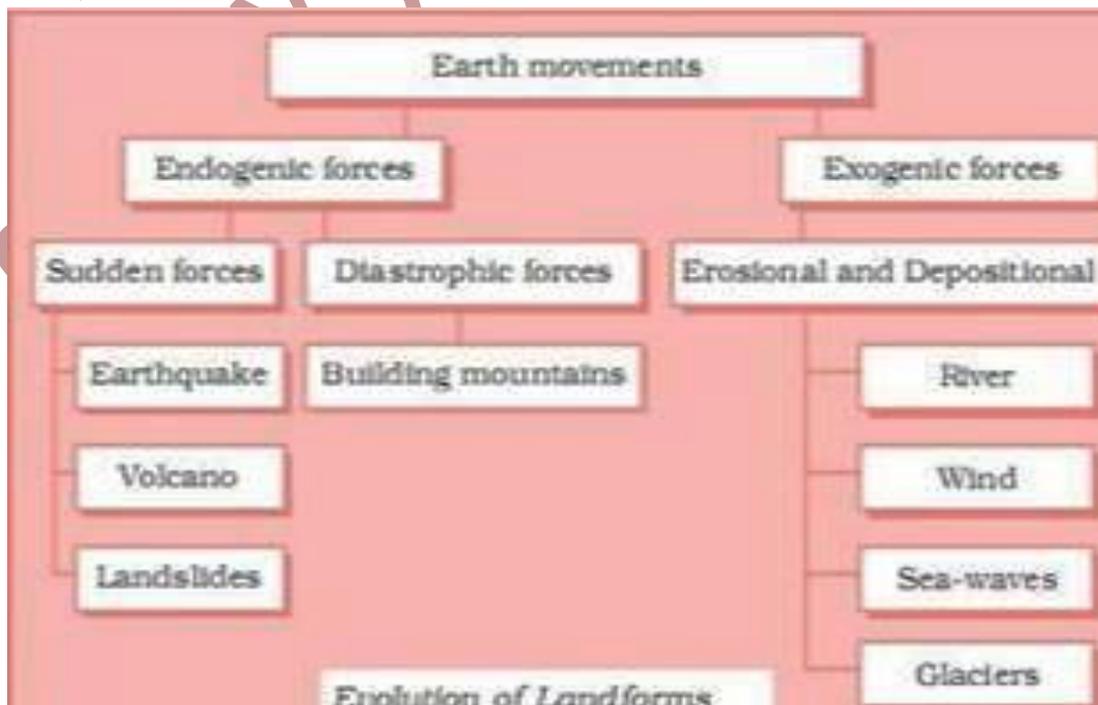
### Why earth is uneven?

- Due to internal and external forces earth is changing its surface conditions.
- The earth crust is always dynamic It moves vertically and horizontally
- The differences in the internal forces making the surface uneven Wearing down of relief features is called gradation.

- The endogenic forces always elevate parts of the earth's surface and hence the exogenic processes fail to even out the relief variations of the surface of the earth.
- Variations remain as long as there is difference between endogenic and exogenic forces.
- The surface of the earth is sensitive. Human being is using the surface intensively and extensively.

## GEOMORPHIC PROCESSES

- The endogenic and exogenic forces cause physical stress and chemical actions on the earth material and bring the changes in the configuration of the earth surface is called **GEOMORPHIC PROCESSES**
- Diastrophism and volcanism are endogenic processes
- Weathering, Mass wasting, Erosion & Deposition Are Exogenic Processes Any Exogenic Element Of Nature Capable Of Acquiring And Transporting Earth Materials Can Be Called A Geomorphic Agent.
- They Become Mobile When There Is Gradient



## The Erosional Agents Are

1. Running Water,
2. Moving Ice,
3. Wind,
4. Underground Water,
5. Waves

- A process is a force applied on earth materials affecting the same) agent is a mobile medium which removes transports and deposits earth materials, activity also causes directional forces activating downslope movements of matter waves and tides are indirect movements of the earth caused by gravitation Without gravity and gradient there is no mobility for erosional agents as a result there is no erosion transportation, and deposition on the earth surface.
- All the movements on/in the earth are due to gravitation and gradient. from higher level to lower level and high pressure to low-pressure areas

## ENDOGENIC PROCESS:

- The energy generating from within the earth is the main force behind the endogenic geomorphic processes.
- The energy generated due to
  1. Radioactivity
  2. Rotational Force
  3. Tidal Friction
  4. Primordial Heat From The Origin Of The Earth.
- Diastrophism And Volcanism Are Due To Geothermal Gradients And Heat Flow From Within The Earth.
- Crustal Thickness, Strength, Action Of Endogenic Forces Are Due To Variations In Geothermal Gradients And Heat Flow Are Uneven.

**DIASTROPHISM:**

All process that move elevate or build up portions of the earth's crust come under

DIASTROPHISM THEY ARE TWO TYPES

1. **OROGENIC PROCESSES:** mountain building through folding
2. **EPEROGENIC PROCESS:** uplifting large part of earth crust
3. **EARTH QUAKES**
4. **PLATE TECTONICS:** involve horizontal movements

**DIFFERENCE BETWEEN OROGENY AND EPEROGENY**

OROGENY	EPEROGENY
Crust is severely damaged Mountain building and faulting cause tension and compression	Simple deformation continental formation upliftment of landmass verticals force

## VOLCANISM:

Movement of molten rock towards the earth's surface and also formation of many intrusive and extrusive volcanic forms.

**Volcanism:** it is the process in which volcanoes takes place Volcanoes are the land forms formed due to volcanic process

## EXOGENIC PROCESSES:

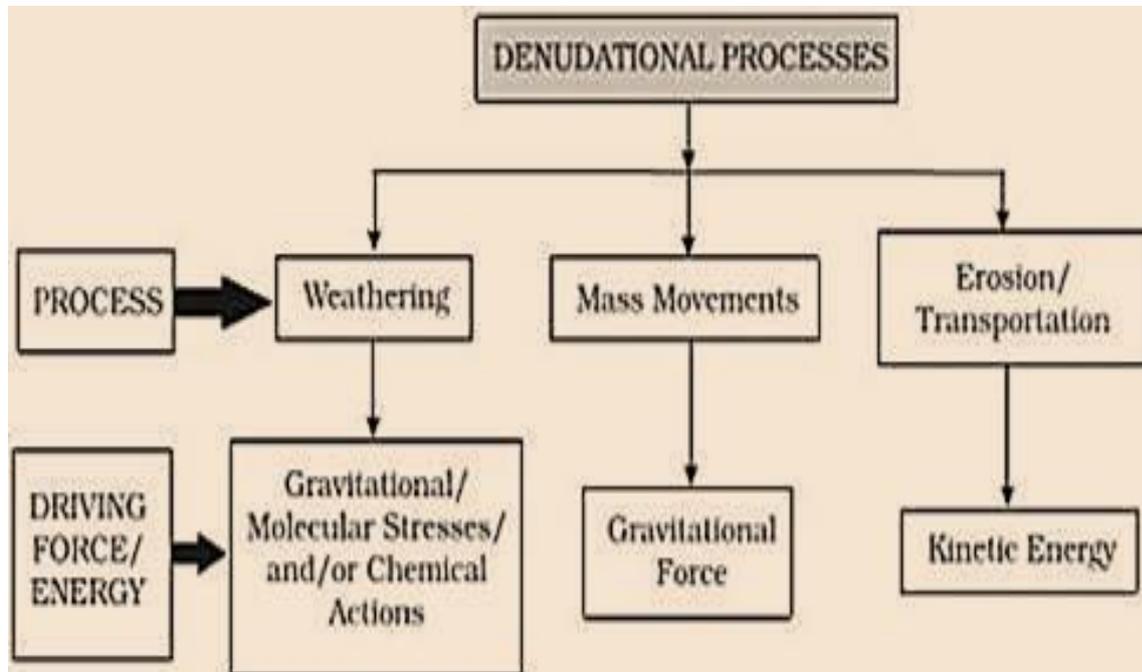
- They derive their energy from atmosphere determined by the prime source The sun and also gradients created by the tectonic factors.
- Gravitational force create gradient towards down slope direction.
- Force applied per unit area is called **STRESS**

### Stress can be produced in a sold body pushing or pulling

- This includes deformation. Forces acting along the faces of earth materials are shear stresses. (seperating forces). It is this stress that breaks rocks and other earth materials. the shear stress result in angular displacement/ slippage. Besides gravitational stress there is molecular stress which is caused by temperature change, crustallisation and melting. chemical processes normally lead to loosening of bonds between grains, dissolving of soluble minerals or cementing materials.
- The basic reason for weathering, mass movement erosion and deposition is the development of stress in the earth materials.
- Since there are different climatic regions there is variation in the exogenic process from region to region. Temperature and precipitation are the two major elements that control various processes.
- All the exogenic process are covered under general term **DENUATION**.

- The word denude means uncover. Weathering, masswasting erosion and transportation are included in denudation.

### DENUATIONAL PROCESSES AND THEIR Driving Forces



This Chart We Observe That For Each Process There Is Driving Force Called Energy On The Earth Surface Thermal Gradient Is Caused By

1. Latitude
2. Seasons
3. Land And Water Distribution
4. Angle Of Earth's Inclination

→ The Density of Natural Vegetation Is Greatly Influenced By The Temperature And Precipitation Helps Indirectly The Exogenic Processes

**THE OTHER FACTORS OF CLIMATIC VARIATIONS ARE**

1. Altitude
2. Angle Of Slope
3. Ocean Currents
4. Amount Of Insolation Received By The Region
5. Wind Velocity And Direction
6. Direccion Of The Slope
7. Amount And Kind Of Precipitation
8. Relation Between Precipitaion And Evaporation
9. Daily Rang Of Temperature
10. Freezing And Thawing Frequency
11. Depth Of Frost Penetration

The Sole Driving Force Behind All The Exogenic Process Is The Sun

**When Climatic Factors Are Common**

The Intensity Of Action Depend On Type And Structure Of Rocks

**STRUCTURE INCLUDES**

- folds, faults, orientation inclination of beds, presence or absence of joints ,bedding planes hareness, softness of constituent minerals, chemical susceptibility of mineral constituents , the permeability or impermeability.
- Different types of rocks offer varying resistances to various geomorphic processes

- Particular rock may be resistant to one process and nonresistant to other process As a result there is varied relief over the earth surface
- The effects of exogenic forces may be small and slow but in long run they have greater effects Finally the surface of the earth is operated by different geomorphic processes and at varying rates

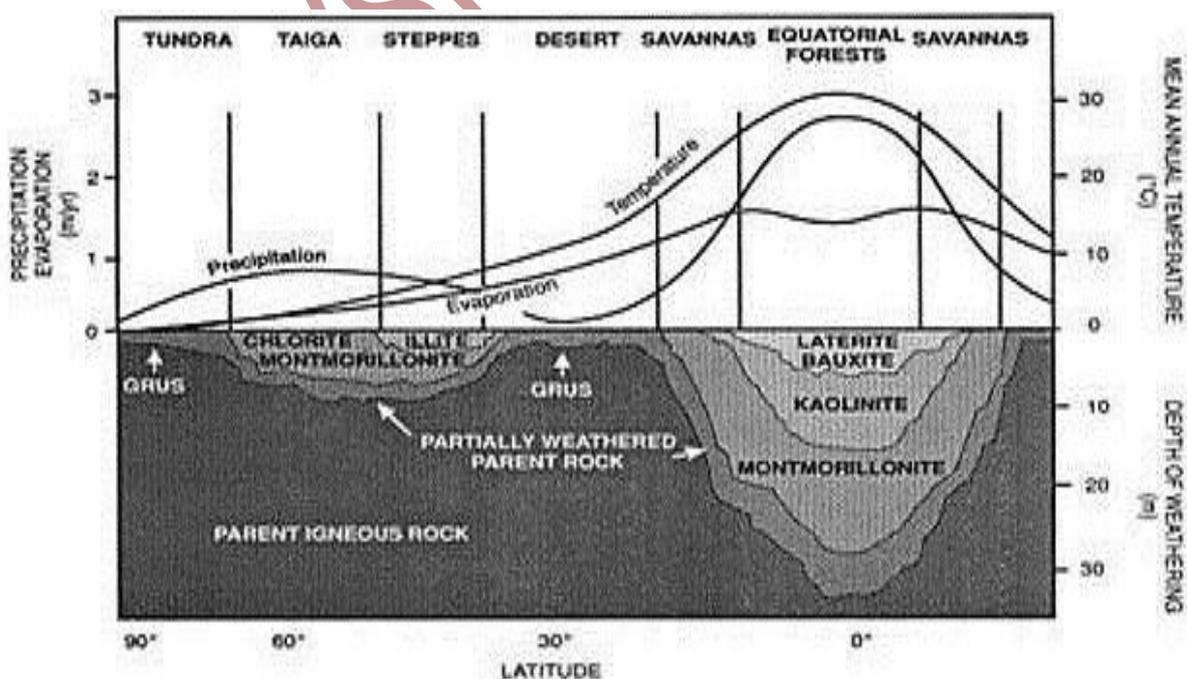
## WEATHERING

it is the action of elements of weather on earth materials.

**Weathering** is defined as mechanical disintegration and chemical decomposition of rocks through the actions of various elements so weather and climate In weathering there is no motion of materials takes place so it is in-situ or on site process

## FACTORS INFLUENCING THE WEATHERING & DEPTH OF WEATHERING

I) CHEMICAL (II) PHYSICAL/MECHANICAL (III) BIOLOGICAL WEATHERING



## I) CHEMICAL WEATHERING PROCESSES

- A group of weathering processes viz; solution, carbonation, hydration, oxidation and reduction act on the rocks to decompose, dissolve or reduce them to a fine clastic state through chemical reactions by oxygen, surface/soil water and other acids.
- Water and air along with heat must be present to speed up all chemical reactions.
- Over and above the carbon dioxide present in the air, decomposition of plants and animals increases the quantity of carbon dioxide underground.
- These chemical reactions on various minerals are very much similar to the chemical reactions in a laboratory.
- $\text{CO}_2$  is dissolved in carbonic acid and washed away to form the caves in lime stone region.
- Clay minerals are easily eroded due to the presence of minerals which can exchange the ions with the water.

## II) PHYSICAL WEATHERING PROCESSES

- Factors Influencing The Physical Weathering
  1. Gravitational Force Overburden Pressure, Load And Shearing Stress
  2. Expansion Forces Due To Temperature Changes, Crystal Growth Or Animal Activity
  3. Water Pressures Controlled By Wetting And Drying Cycles.
- They are mostly due to thermal expansion, and pressure release. The repeated action of these processes cause damage to the rocks

### BIOLOGICAL WEATHERING:

- Removal or contribution of ions to the environment due to biological activity is called biological weathering.
- burrowing and wedging by organism like earthworms termites, rodents help in exposing the new surfaces to chemical attack and assists in the penetration of moisture and air.
- **Solts are common features U shaped valleys and moraines are common Ex. Sahara, Atacama Kalahari Amazon.**

### SPECIAL EFFECTS OF WEATHERING:

**Exfoliation** is a result but not a process. Removal of layers from curved surfaces result into rounded surfaces. It occurs due to expansion and contraction induced by temperature changes. Exfoliation domes occur due to unloading whereas tors occur due to thermal expansion.

### SIGNIFICANCE OF WEATHERING:

- Responsible for the formation of soils and erosion and deposition.
- biodiversity is basically depending on depth of weathering. erosion may not be significant when there is no weathering.
- weathering aids mass wasting, erosion and reduction of relief and changes in landforms.
- weathering of rocks and deposition helps in the enrichment and concentrations of certain valuable ores of iron manganese, aluminium copper. It is an important process of soil formation

### ENRICHMENT:

When rocks undergo weathering some materials are removed through chemical or physical leaching by ground water and thereby the concentration of remaining materials increases.

Without such a weathering taking place, the concentration of the same valuable material may not be sufficient and economically viable to exploit, process and refine, this is what is called enrichment

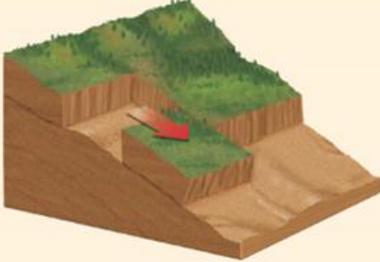
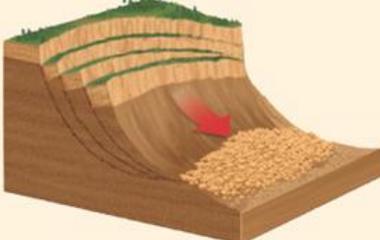
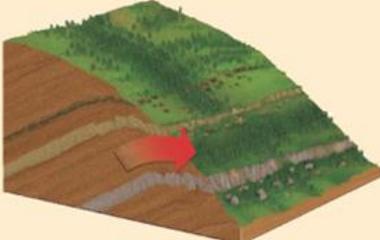
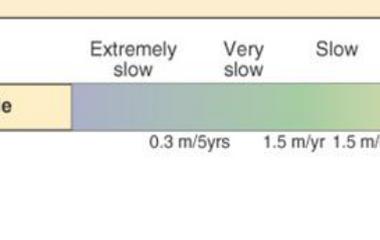
### **MASS MOVEMENT:**

these movements transfer the mass of rock debris down the slopes under the direct influence of gravity. air water ice do not carry debris, but debris carry them. the movements of mass may range from slow to rapid.

### **Activating causes precede mass movements:**

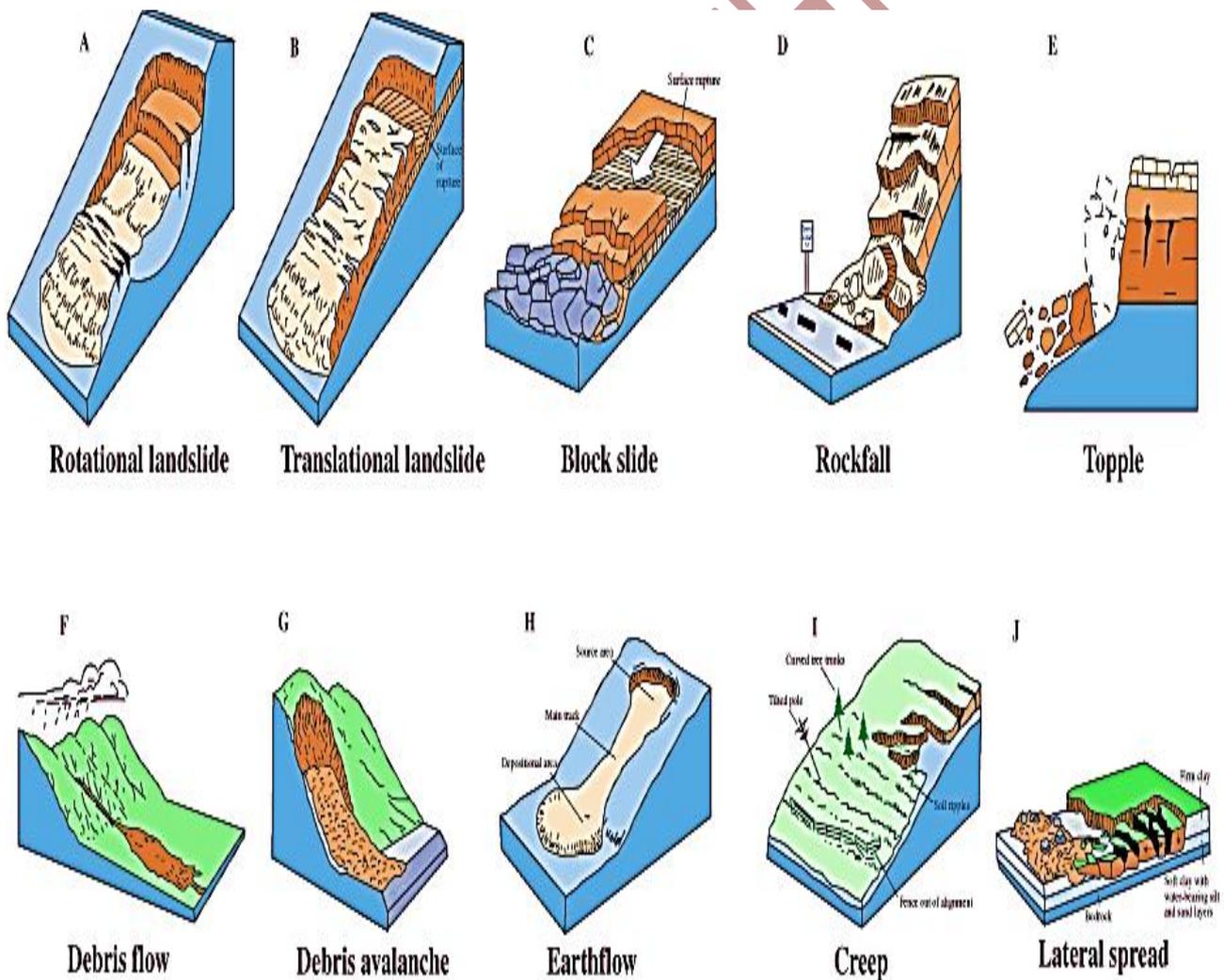
- (i) removal of support from below to materials above through natural or artificial means
- (ii) increase in gradient and height of slopes
- (iii) overloading through addition of materials naturally or by artificial filling
- (iv) overloading due to heavy rainfall saturation and lubrication of slope materials
- (v) removal of material or load from over the original slope surfaces.
- (vi) occurrence of earthquakes, explosions or macunery
- (vii) excessive natural seepage
- (viii) heavy draw down of water from lakes, reservoirs and rivers (ix) indiscriminate removal of natural vegetation

## CLASSIFICATION OF MASS MOVEMENTS

Type of Movement	Type of Material	
<b>Fall</b> 	<b>Rock</b>	<b>Regolith</b> Debris: coarse > fine Earth: fine > coarse
	Rock Fall	Debris/Earth Fall
Extremely rapid		
Rapid to extremely rapid		
<b>Slide</b> Planar rupture surface: Slide  Curved rupture surface: Slump 	Rock Slide	Debris/Earth Slide
	Very slow to extremely rapid	
	Very slow to very rapid	
	Rock Slump	Debris/Earth Slump
Extremely slow to moderate		
Very slow to very rapid		
<b>Flow</b> Slow: Creep  Fast: Flow  Very fast: Avalanche 	Rock Creep	Debris/Earth Creep
	Extremely slow to slow	
	Extremely slow to slow	
		Debris/Earth Flow
	Very rapid	
Debris avalanche (rock and regolith)		
Very rapid to extremely rapid		
<b>Velocity scale</b>	Extremely slow    Very slow    Slow    Moderate    Rapid    Very rapid    Extremely rapid 0.3 m/5yrs    1.5 m/yr    1.5 m/month    1.5 m/day    0.3 m/min    3 m/sec	

## TYPES OF MASS MOVEMENTS:

- **creep, flow, slide and fall.** mass movements are active over weathered slopes than unwethered slopes.
- mass movements are aided by gravity not any erosional agent. mass movements do not come under erosion though there is shift of material.
- When force is greater than resistance mass movement occurs.
- Ex. Weak unconsolidated material, thinly bedded rocks, faults, steeply dipping beds, vertical cliffs, steep slopes, abundant precipitation and torrential rains and scarcity of vegetation



**CREEP:**

It generally occurs on moderately steep, soil covered slopes.

Movement of material is extremely slow. Material may be rock debris or soil

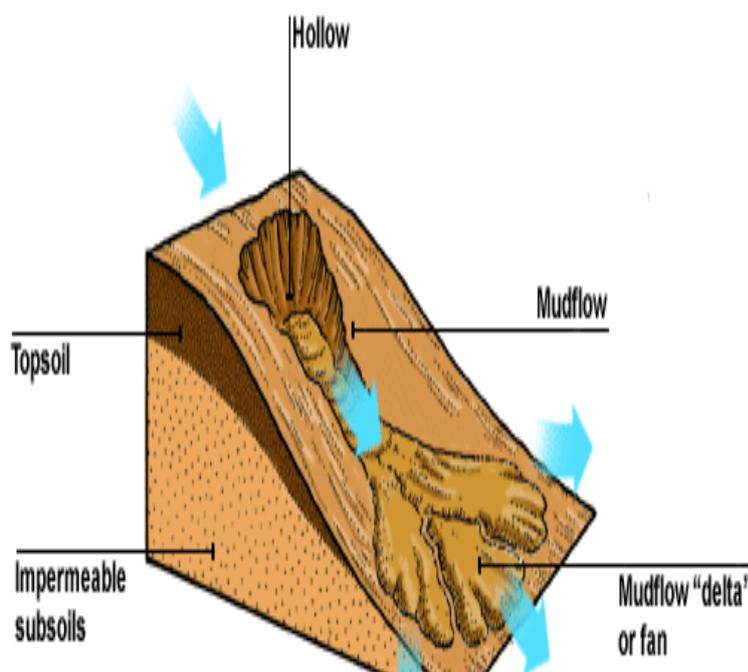
Ex. Bending of telephone pole, and fence poles.

Types of creep: soil creep, talus creep rock creep rock glacier creep

**Solifluction:**

slow down slope flowing soil mass or fine grained rock debris saturated or lubricated with water.

It is common in moist temperate areas where surface melting of deeply frozen ground and long continued rain respectively occur frequently.

**MUD FLOW RAPID MOVEMENTS CONDITIONS**

1. Humid climatic regions
2. gentle to steep slopes
3. Heavy rain
4. Loose soils

### EARTH FLOW:

- movements of water saturated clayey or silty earth materials down low angle terraces or hillsides. EARTHFLOW
- In the absence of vegetation cover and with heavy rainfall, thick layers of weathered materials get saturated with water and either slowly or rapidly flow down along definite channels. it looks like a channels of mud. when they overflow the channels they engulf the roads and rail bridges.
- They generally occur due to volcanic eruptions. Volcanic ash dust and other fragments turn into mud due to heavy rains and flow down as tongues or streams of mud causing great



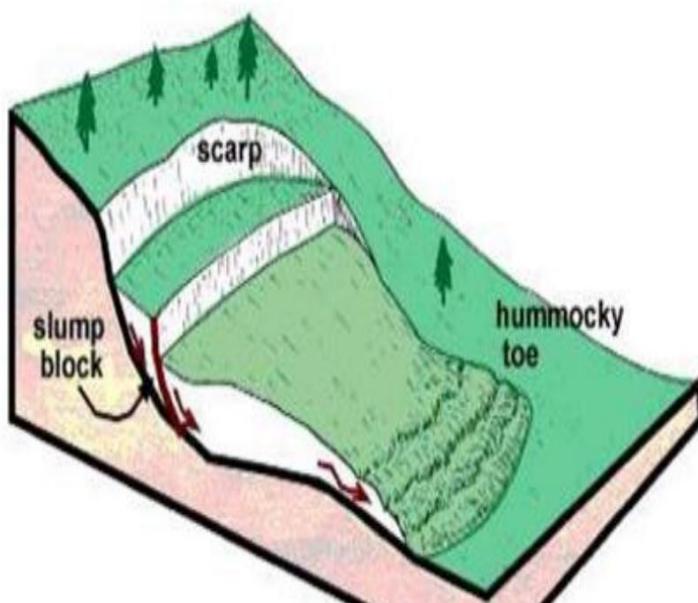
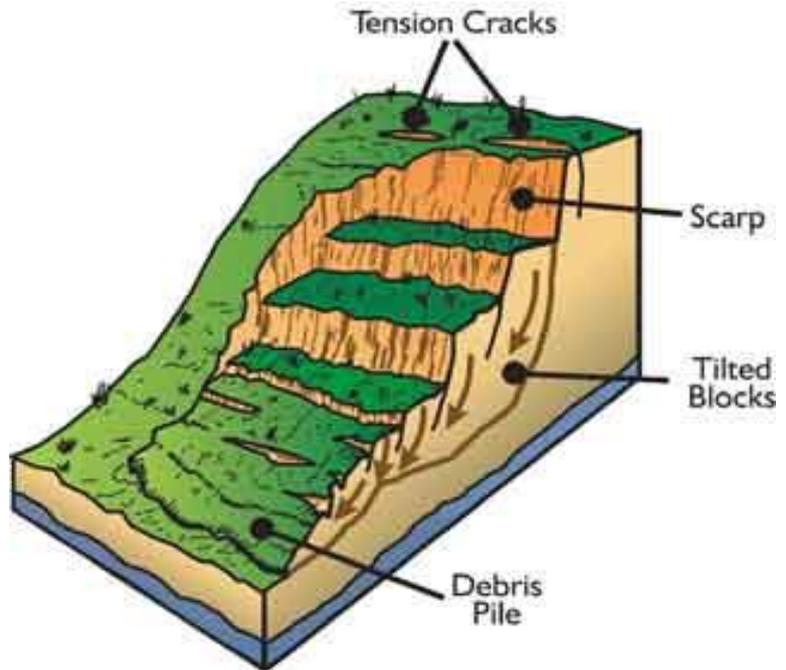
### DEBRIS AVALANCHES:

- Found in humid regions with or without vegetation in narrow tracks of steep slopes.
- It is much faster than mud flow, it is similar. to snow avalanches.



### LANDSLIDES:

- these are rapid and perceptible movements.
- dry materials are found. the size and shape of the materials are depending on the nature of the rock, degree of weathering, steepness of slope.
- slipping of one or several units of rock debris with a backward rotation with respect to the slope over which the movement takes place



### DEBRIS SLIDE:

- rapid rolling or sliding of earth debris without backward rotation of mass is known as debris slide.

## Rockslide

- sliding of individual rock masses down bedding joint or fault surfaces. it generally occurs at the steep slopes. Superficial layers of the rock generally fall.

## Mass movement

Reasons for land slides along the Himalayas

1. Tectonically active
2. Made of sedimentary rocks
3. Steep slopes
4. Heavy rains
5. Unconsolidated material is found

## EROSION AND DEPOSITION

- Erosion involves acquisition and transportation of rock debris  
Abrasion by rock debris carried by geomorphic agents also aids erosion
- By erosion relief degrades. the landscape is work down.  
Weatherin may not be precondition for erosion.
- Weathering, mass wasting, and erosion are degradational processes. It is the erosion largely responsible for continuous changes that the earth surface is undergoing.
- Erosion and transportation are controlled by kinetic energy. wind running water and glaciers are controlled by climate.

### Comparison of wind running water and glacier

Wind	Running water	Glacier
Predominant in hot deserts	Found most parts of the earth	Found only in high latitude and altitude
Sand dunes are common features	Valleys and deltas are common features	U shaped valleys and morians are common
Ex. Sahara, atacama Kalahari	Amazon.Nile, Bramhaputra	Greenland, Antarctica
Air is gas	Water is liquid	Glacier is solid
Limited land forms	Extensive land forms	Limited land forms
High speed	Normal speed	Very slow movement

**EROSION:**

"application of kinetic energy associated with the agent to the surface of the land along which it moves".

It is computed as  $KE = \frac{1}{2} mv^2$

M=mass v= velocity KE= kinetic energy

**SOIL FORMATION:**

Soil is the collection natural bodies on the earth's surface containing living matter and supporting or capable of supporting plants.

Soil is a dynamic material in which many chemical, biological, and physical activities go on constantly. It is the result of decay, it is also a medium of growth. It is changing and developing body. Characteristics are changing from season to season.

Too cold, too hot, and dry areas biological activity stops. organic matter increases when leaves fall and decompose.

**PROCESS OF SOIL FORMATION:**

weathering is basic process for soil formation. The weathered material is transported and decomposed due to bacteria lichens and moss. The dead remains increases the humus of the soil. minor grasses and ferns can grow. Bushes, trees also grow. plants roots and burrowing animals help the soil formation.

**PEDOLOGY:**

is science of soil formation

**PEDOLOGIST:**

is the scientist of soil formation

#### SOIL FORMING FACTORS:

1. Parent material
2. Topography
3. Climate
4. Biological activity.
5. time

#### PARENT MATERIAL:

passive control factor, it is insitu, onsite, or transported. it depends on texture, structure, chemical composition of the soil. Nature and depth of weathering is an important factor. chemical composition, texture are the characteristics derived from parent material

#### TOPOGRAPHY:

passive control factor, amount of exposure to the sun light, drainage system, steep slopes have less deposition, gentle slopes have thick soils. Plains have thick and dark coloured soils. In mid latitude southern slopes expose to the sun light and get decomposed more.

#### CLIMATE:

it is an active factor in soil formation. Climatic elements are (i) moisture (interms of its intensity, frequency and duration of precipitation -evaporation and humidity (II) Temperature in terms of seasonal and diurnal variation. Precipitation increases the biological activity. Excess of water helps to transport the dissolved particles to downward (eluviation)

**Deposition of these particles is called 'Illuviation'**

- Heavy rainfall removes the calcium, magnesium, sodium, potassium along with silica.
- Removal of silica is called desilication
- In dry areas excess of evaporation leads to deposition of salts on the surface of the soil These salt layers are called 'hard pans' in the hot deserts
- In tropical climates, under moderate rainfall conditions calcium carbonate nodules are formed.

### Biological activity:

plants and animals add organic matter to the soil. also helps in moisture retention. Dead plants add humus to the soil In humid areas, the bacterial activity is higher than cold areas As a result undecomposed material is found in cold areas In hot areas bacteria fix the nitrogen in the soil which is used by the plants Rhizobium is the bacteria fix the nitrogen in the soil and live in the roots of legumenace plantsants, temites, rodents, earthworms change the chemical composition of the soil.

### Time:

Important controlling factor of soil formation. Longer the time, thicker the soil layers. No time limit for the formation of the soil layers.