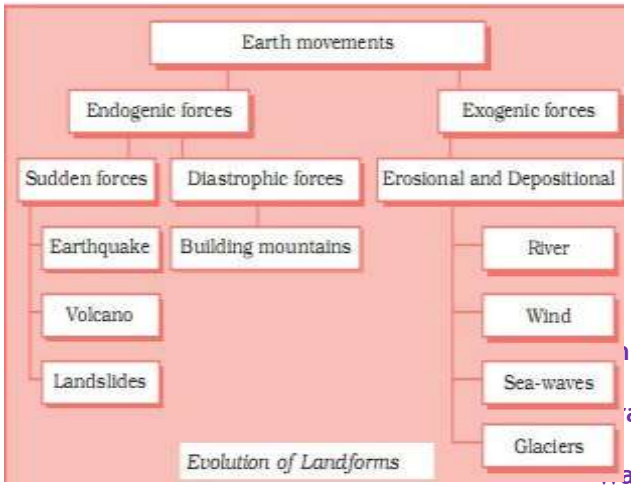
CHAPTER -6 GEOMORPHIC PROCESSES

This chapter deals with Geomorphic process,exogenic,endogenic processes,diastrophism,volcanism,weathering,types of weathering mechnical(unloading ,expansion,temperature change expansion freezing thawing frost wedging salt weathering), chemical (solution, carnonation,hydration oxidation and reduction),biological (plants, animals man).biological activity and weathering, special effects of weathering, significance of weathering, mass movement,slow movement, rapid movementland slide, erosion , deposition, soilformtion, process of soil formation soil forming factors, parent material, topography, climate, biological activity, time.

1. 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 parrts 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, Masswasting,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.
avity also causes directional forces activating downslope movements of matter
aves and tides are inderect movements of the earth caused by gravitation
With out 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 with in the earth is the main force behind the endogenic geomorphic processes.

The energy genarated due to
1. Radioactivity 2.Rotational Force 3.Tidal Friction 4.Primordial Heat From The Origin Of The Earth.
Diastrophism And Volvanism Are Due To Geothermal Grdients 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 duild up portions of the erth'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 process Folding and faulting Cause tension and comprssion	simple deformation continental formation upliftment of landmass vertical 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 DENUDATION.
The word denude means uncover. Weathering , masswasting erosion and transportation are included in denudation.

DENUDATIONAL PROCESSES AND THEIR Driving Forces

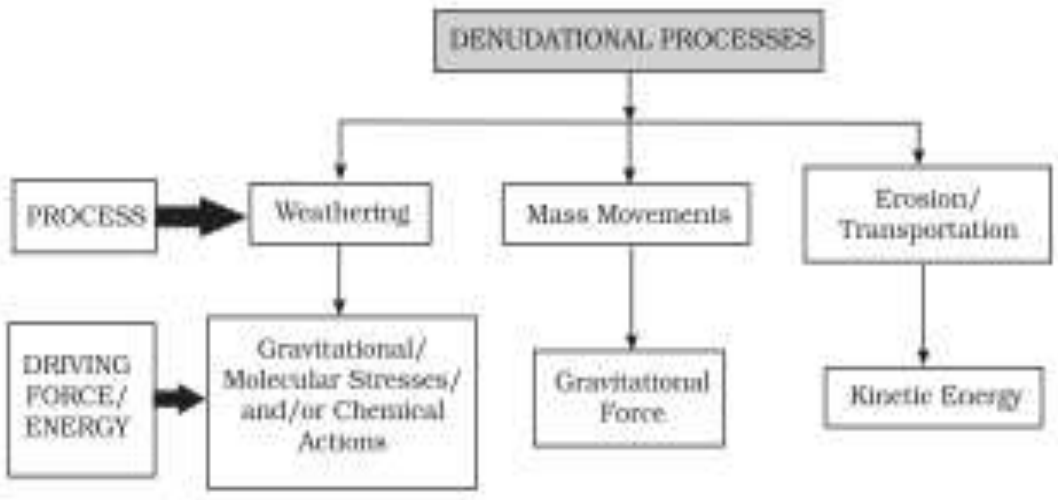


Figure 6.1 : Denudational processes and their driving forces

In

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 Earh's Inclination

The Densityof Natural Vegetation Is Greatly Influenced By The Temperature And Precipitation Helps Indirectly The Exogenic Processes.

THE OTHER FACTORS OF CLIMATIC VARIATIONS ARE1.Altitude 2. Angle Of Slope 3. Ocean Currents 4.Amount Of Insolation Received By The Region 5. Wind Velocity And Direction 6. Direcion Of The Slope 7. Amount And Kind Of Precipitation 8.Relation Between Precipitaion And Evaportion 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 non resistant 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 inlong run they have greater effects

Finally the surface of the earth is operated by different geomorphic processes and at varying rates

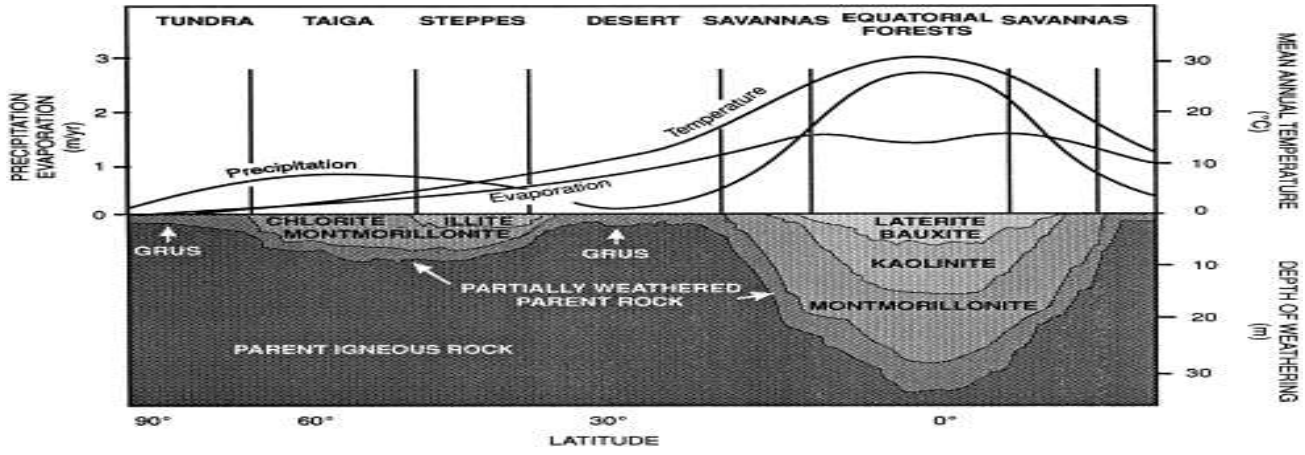
WEATHERING: it is the acion of elements of weather on earth materials

Weathering is defined as mechanical disintegration and chemical deconposition of rocks through the actions of various element so fweather and climate

In weathering there is no motion of materials takes place so it si in-situ or on site process

FACTORS INFLUENCING THE WEATHERING& DEPTH OF WEATHERING

1.GEOLOGICAL STRUCTURE 2.CLIMATE 3.TOPOGRAPHY 4. NATURAL VEGETATION



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

CHEMICAL WEATHERING PROCESSES

Agroup of weathering processes viz; solution , carnonation, hydration , oxidation and reduction asc on the roks to decompose, dissolve orreduce 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 quanitity of carbon dioxide underground . these chemical reactions on various minerals are very much reactions on various minerals are very much similar to the chemical reactions in a laboratory.

SOLUTION: the water /acid with dissolved content is called solution. This process involves removal of solids in solution and depends upon solubility of amineral in water or weak acids.when water reacts with any solid many solids may become solution. Ex. Sulphates, nitrates, potassium .
When rain comes these solids dissolve into solution with out leaving any residue.

Calcium carbonate , magnesium bicorbanate present in the lime stone are dissolved in and form carbonic acid,CO^2 produced by decaying organic matter along with soil water greatly aids inthis reaction . Common salt is also suceptible to this process.

CARBONATION: It is the reaction of carbonate and bicarbonate with minerals such as feldspar, & carboinate minerals CO^2 from atmosphere and soil air is absorbed by water to form carbonic acid.CaCO^3& Mg$CO^3$are 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 .
HYDRATION: it is the chemical addition of water . minerals take up water and expand . this expansion increases the volume of material.ex. calcium sulphate takes water and convert into gypsum.it is unstabel than calcium sulphate.it is reversible reaction and when this process continuous for longer time the materials diintegrates.
Many clayminerals swell and contract during wetting and drying and a repetition of this process results in cracking of overlying materials.salts inpore spaces undergo rapid and repeated hydration and help in physical weathering through exfoliation and granular disintegration
OXIDATION AND REDUCTION
Oxidation means combination of minerals with oxygen to form oxides and hydroxides.
Oxidation occurs when there is sufficient water and atmosphere. EX. Iron, manganes, sulphur, In the process of oxidation breakdown occurs due the addition of oxygen.red colour of iron becomes into yellow colour.when oxidised minerals re kept in the places where there is no oxygen reduction takes place.ex. such conditions occurs below water table waterlogged areas. Red colour of iron becomes greenish or bluish grey.

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
UNLOADING AND EXPANSION: Removal of overlying rock load because of continued erosion causes vertical pressure release with the result that the upper layers of the rock expand producing disintegration of rock masses.fractures will develop parallel to the ground surface. In areas of curved ground surface aarched fracaatures tend to produce massivce sheets or exfoliation slabs of rock.exfoliation sheets resultinf from expansion due to unloadinf and pressure release my measure hundreds or even thousands of metres in horizontal extent.large smooth rounded domes called exfoliation domes result due to this process

TEMPERATURE CHANGES AND EXPANSION: Various minerals found in the rocks expand at different rates when temperature increases. Each one pushes others. When temperature falls contraction takes place.because of diurnal changes in temperature the effects is mostly on superficial layers of the rocks.the effects of this process is significant in hot deserts and cold deserts.though it is small the continuous process for longer time and larger area the effect is greater. The effect is greater at the depth of the rocks.fractures occurs parallel to the surface.due continuous expansion and contraction the rock layers become lose and exfoliation takes place.a large dome shaped structures are formed due to this process. Tores which are large boulders also form due this process.exfoliated domes are big insize where as exfoliated tores are varied sizes.

FREEZING THAWING AND FROST WEDGING:due to repeated freezing and melting frost weathering occurs in the pores and cracks of rocks.it is most effective in higher elevations of the midlatitudes.

Glacial areas are suhjected to frost wedging daily . In this process the rate of freezing is more important. Rapid freezing causes sudden expansion an dhigh pressure. Finally this process makes the rock to break into pieces

SALT WEATHERING; salts in the rocks expand due to thermal action hydration and crystallisation.ex. Calcium sodium magnesium potassium and barium .high temperature between 30℃ to 50℃ of surface temperature indesertrs favour such salt expansion.

Salt crystals in near surface porescause splitting of individual grains within rocks,.which eventually fall off. This process of falling off of individual grains may result in granualr disingetrationor granular foliation.

Salt crystallisationis most effective of all salt weathering processes, in areas with alternating wetting and drying conditions salt crystal growth is favoured and the neighbouring grains are pushed aside.sodium chloride and gypsum crystals in desert areas heave up overlying layers of materials and with the result polygonal cracks develop all over the heaved surface. With swalt crystal growth, chalk breaks down most readily followed byLimstone ,Sandstone ,Chalk ,Gneiss And Granite .

BIOLOGICAL WEATHERING: Removal or contribution of ions to the environment due to biological activity is called biological weathering.burrowing and wedging by organism like earthworks tremites, rodents help in exposing the new surfaces to chemical attack and assists in the pentration of moinsture and air..

SOME SPECIAL EFFECTS OF WEATHERING: Exfoliation is a is a result but not a process . Removal of layers from curved surfaces result into rounded surfaces.it occurs due to expansion and contraction dnduced by temperature changes.exfoliation domes occur due to unloading where as tors occurs 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 depostion helps in the enrichment and concentrations of certain valuable ores of iron manganaese , 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 concentrationof 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 donot carry debris ,but debris carry them.the movements of mass may range from slow to rapid.

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 diffing beds, vertical cliffs ,steep slopes , abundant prefipitation and torrential rains and scarcity of vegetation.

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 slpes

(iii)overloading through additionof materials naturally or by artificial filling

(iv) overloading due to heavy rainfall saturation and lubrication of slope materials

(v)removel 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

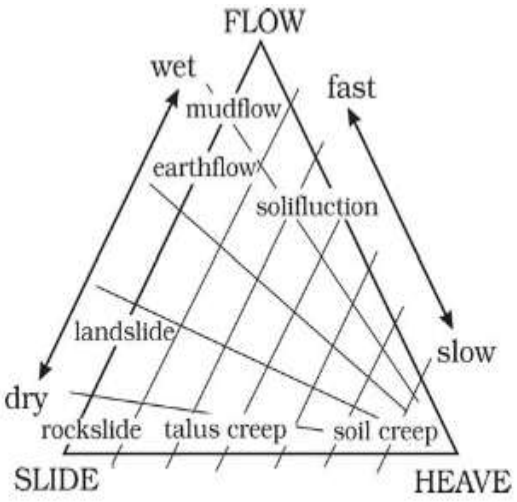
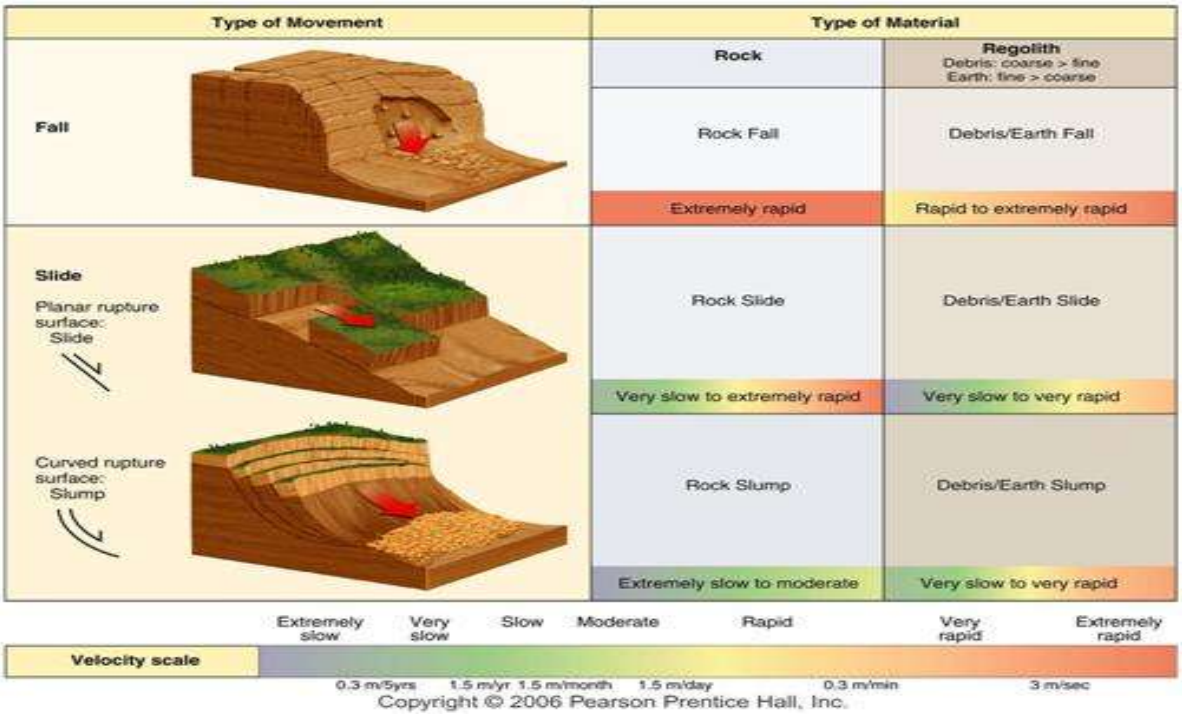


Figure 6.5 : Relationships among different types of mass movements, their relative rates of movement and moisture limits (after Whitehead, 2001)

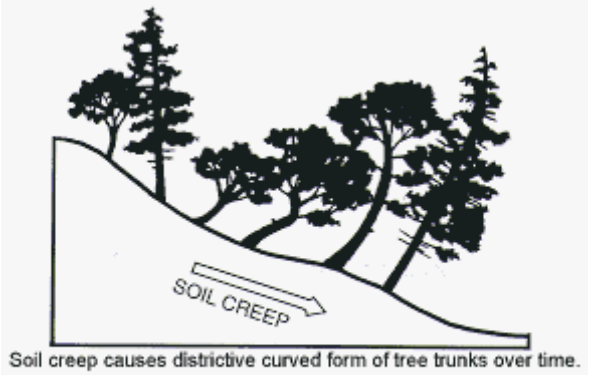


Heave ,flow and slide are the three forms of movements the relationship is shown in the figure no.

The mass movements can be grouped into three types

1.slow movements 2. Rapid movements 3. Land slide

SLOW MOVEMENTS



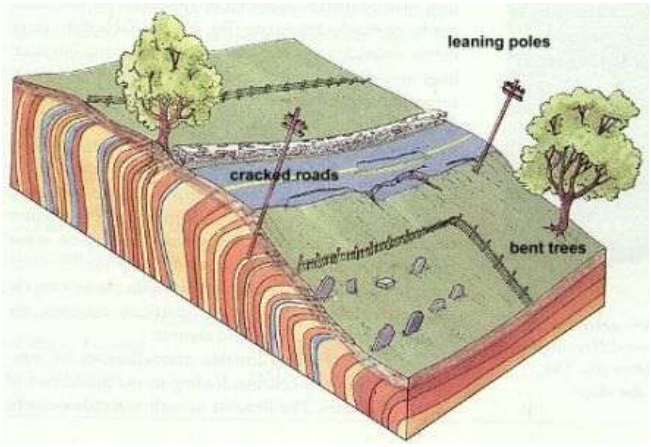
Soil creep causes districtive curved form of tree trunks over time.

Illustration 5:
Indications of Soil Creep

CREEP: It generally occurs on moderately steep, soil covered slopes.

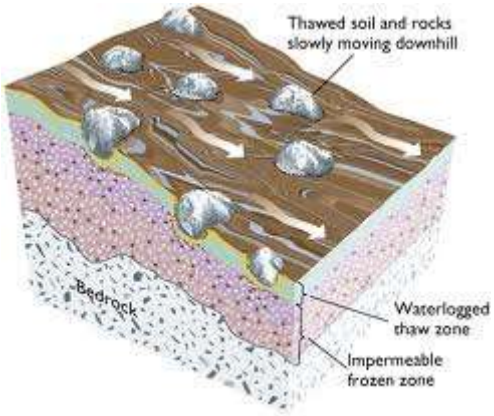
Movement of material is extremely slow. Material may be rockdebris or soil

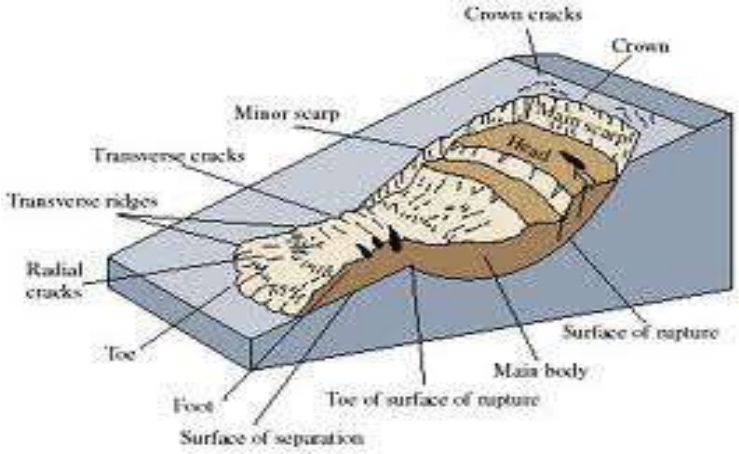
Ex. Bending of telephone pole,and fence poles.



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 erth materials down low angle terraces or hillsides .

EARTHFLOW

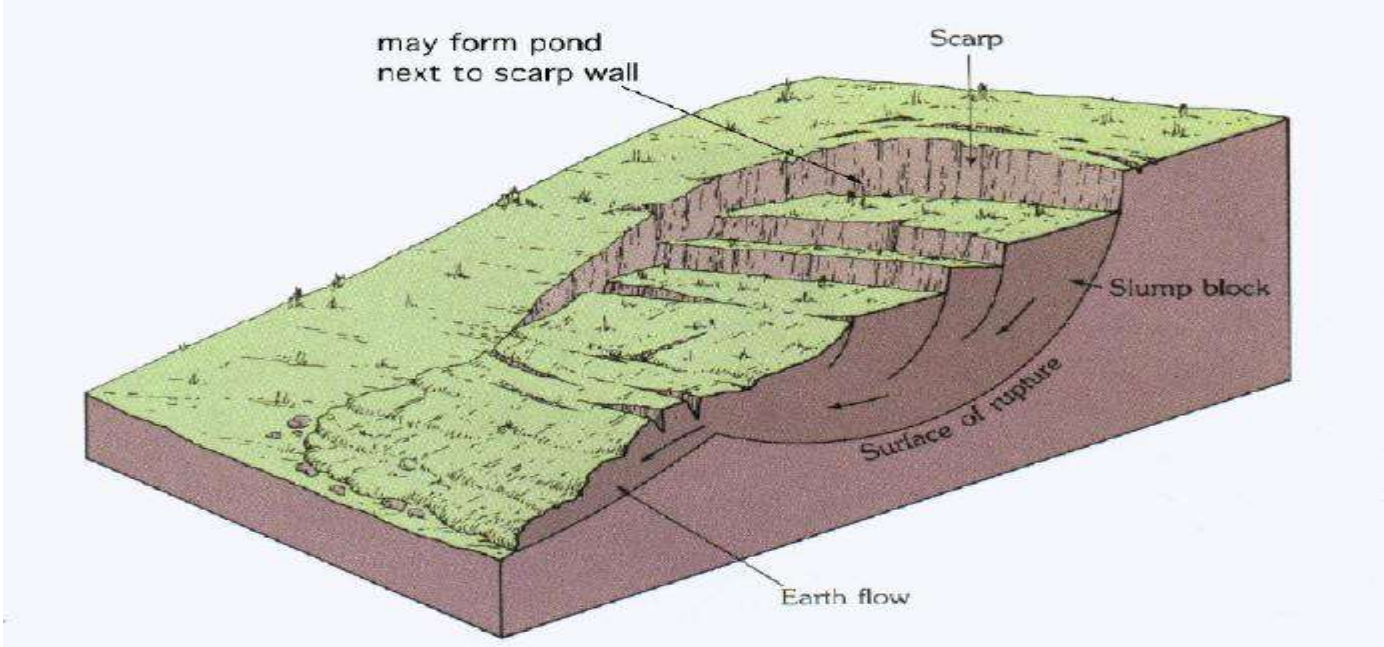
In the absence of vegetation cover and with heavy rainfall,thick layers of weathered materials get saturated with water and either slowly or rapidly flow down along definite channels.it looks like a channels of mud.when they overflow the channels they engulf the roads and rail bridges.

They generally occur due to volcanic eruptions. Volcanic ash dust and other fragments turn intomud due to heavy rains and flow down as tougues or streams ofmud causing great destruction to the human settlements.

DEBRIS AVALANCHES: Found in humid regions with or without vegetationin 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 materaials are depending on the nature of the rock,degree of weathering,steepness of slope.

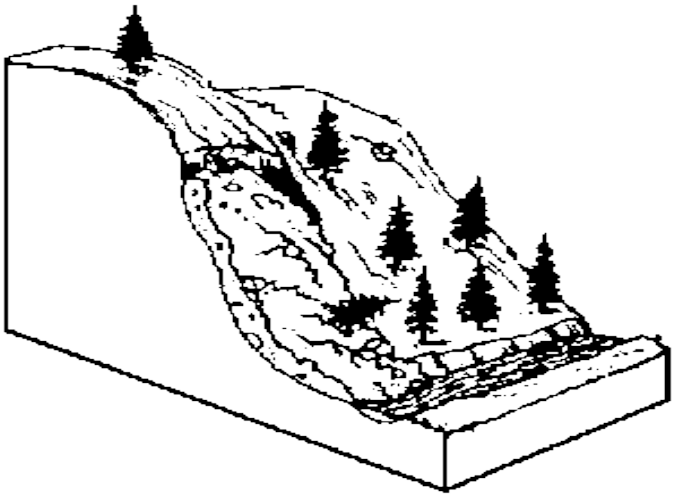
SLUMP:



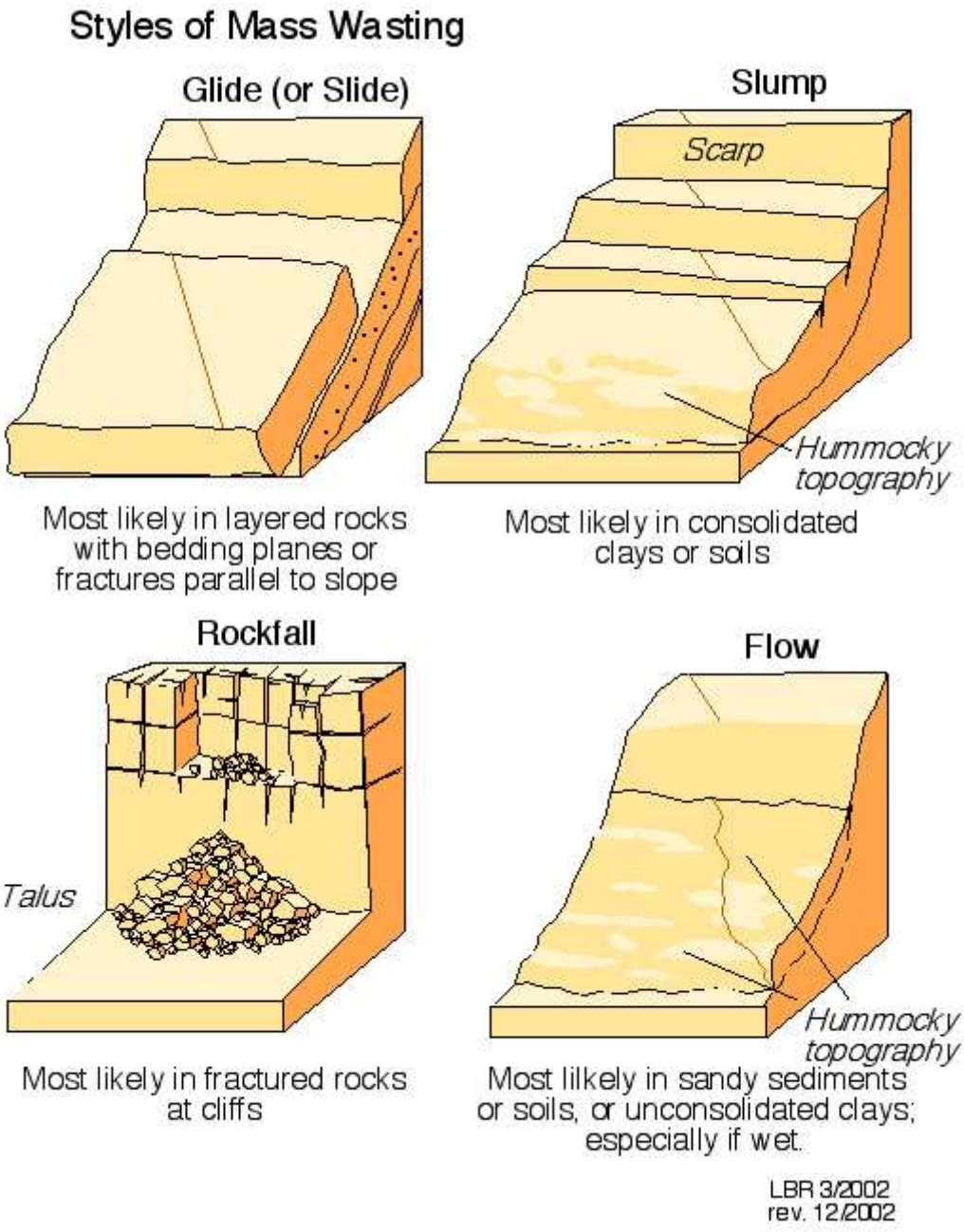
slipping of one or several units of rock debris with a backward rotationwith respect to the slope over which the movement takes place

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

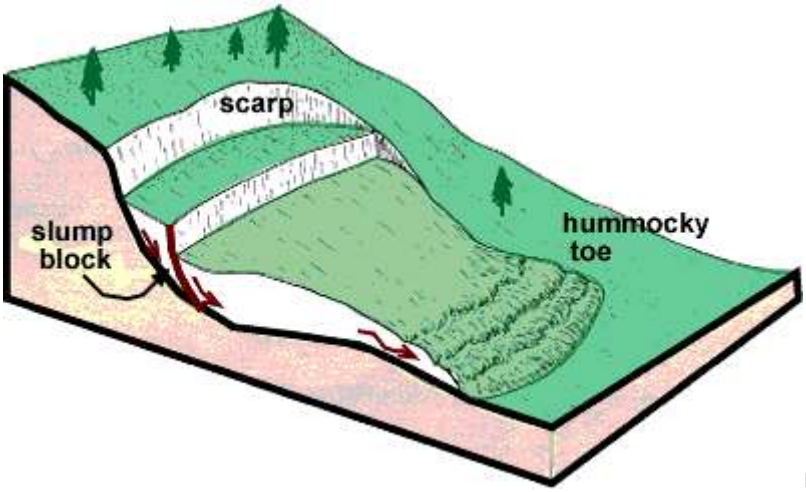
Debris slide



ROCK FALL



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

Abration by rock debris carried by geomorphic agents also aids erosion

By erosion relief degrades . the landscape is work down. Weatherin may not be pre condition for erosion.

Weathering , mass wasting, and erosion are degradational processes. It is the erosion largly 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 runing water and glacier

wind	Running water	glacier
Predominent 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 =½ 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 cpable or suporting plants.

Soil is a dynamic mateial in which many chemical , bioligical , 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 Sceince 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 compositon of the soil. Nature and depth of weathering is an important factor.chemical composition ,texture are the characteristics derived from patent material

TOPOGRAPHY:passive control factor,amount of exposer 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 durationof 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 ,potasium 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 th soil.

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