Geomorphology

Origin:

The word “geomorphology” is originated from three Greek words:

- Ge *(γη):* Earth
- Morfé *(μορφή):* Form
- Logos *(λόγος):* Knowledge

Definition:

“Geomorphology” is the study of landforms of the earth, including their origin and evolution, and the processes that shape them.

It is concerned with the internal geologic processes of the earth's crust, such as tectonic activity and volcanism that constructs new landforms, as well as externally driven forces of wind, water, waves, and glacial ice that modify such landforms.

Geomorphologists seek to understand landform history and dynamics, and predict future changes through a combination of field observation, physical experiment, and numerical modeling.

So, this is the schematic examination of the landforms and their interpretation as records of the past history.

The discipline is practiced within geology, geodesy, geography, archaeology, and civil and environmental engineering.

Notes:

- *Landform: It is the upper layer of earth which includes both oceans and continents.*
- *Geology: It is the science and study of the solid matter that constitute the Earth.*
- *Geodesy: The branch of geology that studies the shape of the earth and the determination of the exact position of geographical points*
- *geography: Study of the earth's surface; includes people's responses to topography and climate and soil and vegetation*

- *Archeology: The branch of anthropology that studies prehistoric people and their cultures*

Aspects of Geomorphology: Salient Features:

- It establishes relation between the land forms and the underlying rocks and is concerned with the interaction between the denundation process and rock forming.

Notes:

Denudation is a useful term summarizing all the processes. By which the exposed rocks of the continents are worn away and the resulting sediments are transported to the sea by the fluid agents. Denudation is the overall lowering of the land surface. It is a useful term for the total action of all processes by which the exposed rocks of the continents are worn away and resulting sediments are transported to the sea by fluid agents.

- It studies the evolution of landscape, which is often called the “denundational chronology”. It is a time based change.
- It studies the actual process of erosion which gives rise to landforms.

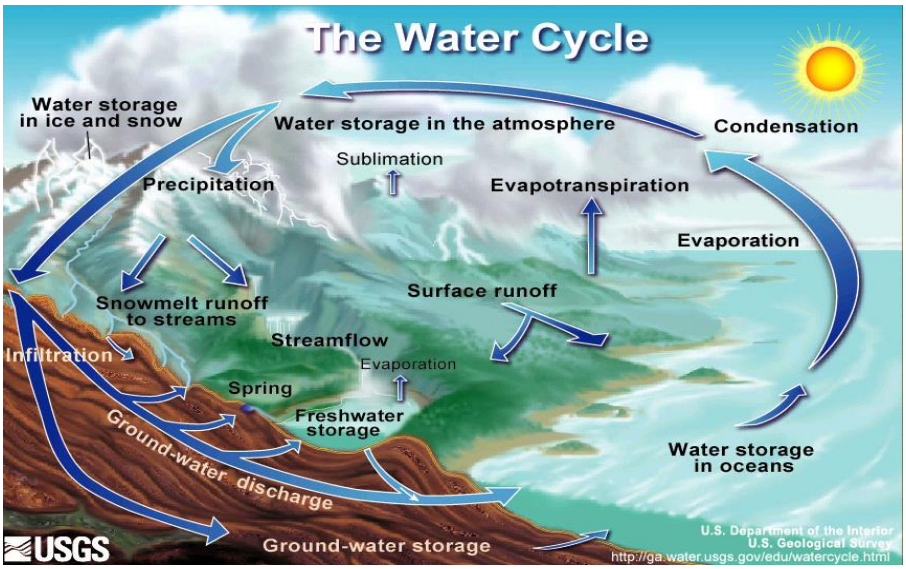
Principal Zones of Earth:

- **Atmosphere:**

  It is the gaseous envelop encircling the earth. Distribution of heat, pressure, and water vapor content within this envelop gives rise to the global weather and climate.

- **Hydrosphere:**

  This is the water envelope on solid earth. Elements of this zone are river, lake, ocean, etc. The movement of water around, over, and through the earth is called the water cycle, a key process of the hydrosphere.



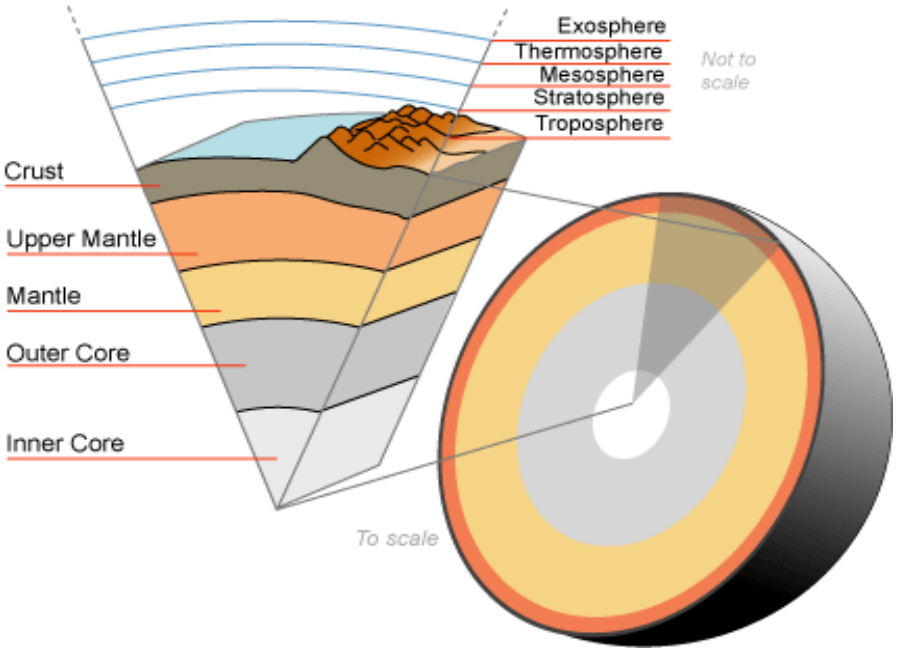
- **Lithosphere/ Geosphere:**

  This is the solid earth.

  Radius: 6400 km

  It has 3 distinct divisions:

  - **Crust:** Thin outer shell: Thickness: 16 – 40 km
  - **Mantle:** The inner zone: Thickness: 2900 km
  - **Core:** Divided into 2 distinct parts:
    - Liquid outer core of nickel iron: Thickness: 2200 km
    - Solid zone called core: Radius: 1300 km



- **Biosphere:**

  This is the life zone of earth. This is the zone of influence upon the geomorphic processes. It includes every living being from small planktons to men.



Movement of Tectonic Plates

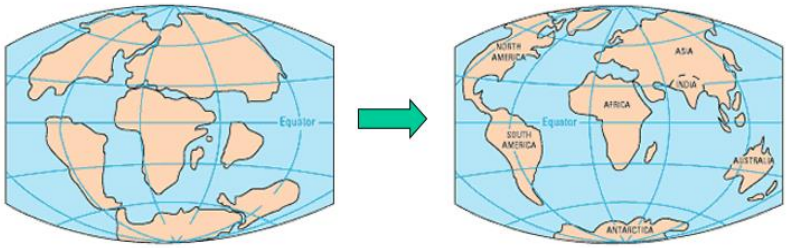
We first need to understand the '**Continental Drift**':



225 million years ago

200 million years ago

135 million years ago

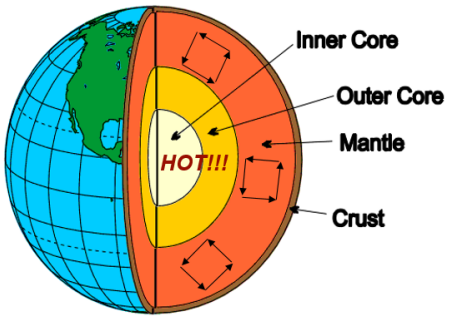


65 million years ago

Present Day

Movement of Tectonic Plates

We first need to understand the EARTH:
Why does the crust move?



*Lithosphere
*Asthenosphere

Driving Force

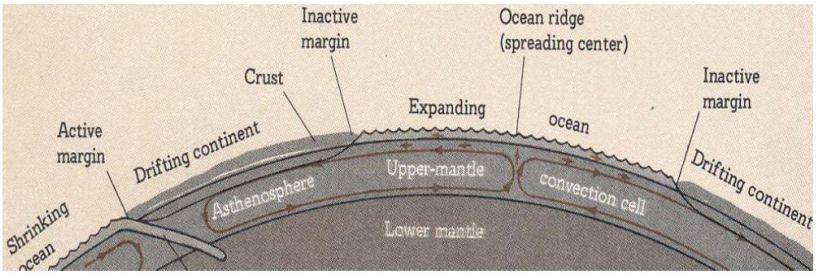
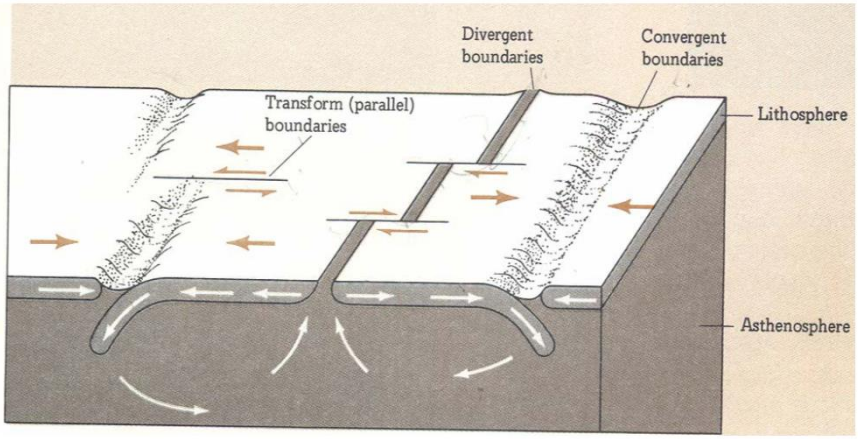
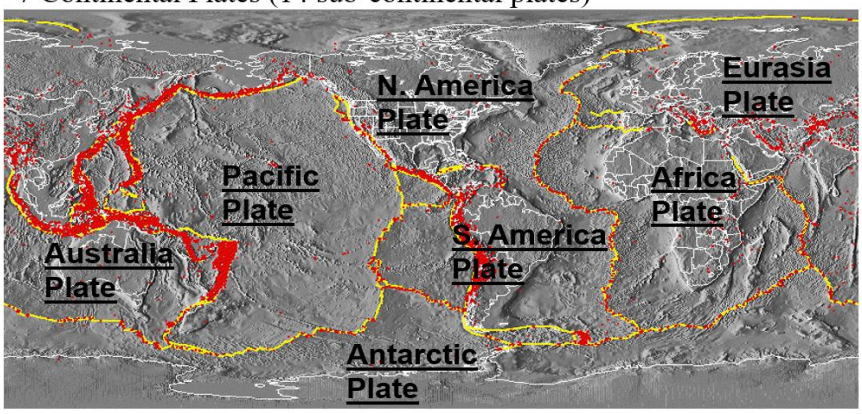


Plate Boundaries



Tectonic Plates = "Pieces of the Crust"

7 Continental Plates (14 sub-continental plates)



Tectonics Plates

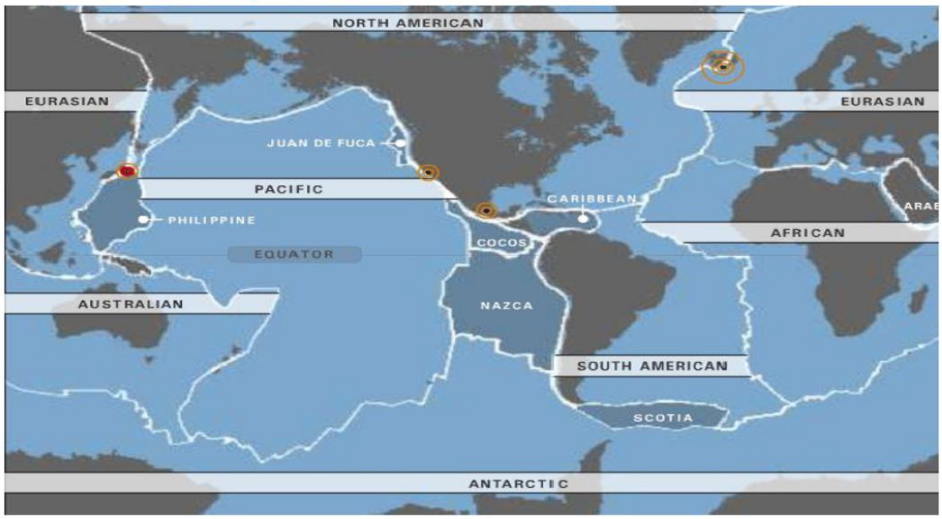
Major Plates:

- Antarctica.
- Africa.
- Eurasia.
- Australia
- Pacific.
- N. America.
- S. America.

Minor Plates:

- India.
- Caribbean.
- Juan de Fuca.
- Nazca.
- Juan de Fuca.
- Scotia.
- Cocos.

Major Tectonic Plates



Geomorphologic Processes

The physical and chemical processes which lead to a modification of the Earth's surficial form are known as geomorphic processes.

- Physical processes:
  Wind blowing on desert, Scouring action of river, etc.
- Chemical processes:
  Weathering of materials due to acid rain.





Geomorphic Agents:

A geomorphic agent is any 'natural medium', which is capable of securing and transporting earth materials.

Thus running water, including both concentrated (muddy) and unconcentrated run-off, groundwater, glaciers, wind and movements within bodies of standing water including waves, currents and tides fall in this group.

Most of the geomorphic agents originate within the earth's atmosphere. And are also directed by the force of gravity. **Gravity itself is not a geomorphic agent** because it cannot secure and carry away materials. It can only move the already dislodged materials. So, it is better thought of as a directional force.

Classification of Geomorphic Processes:

Depending on origin, geomorphic processes are primarily classified into 3 categories:

- **Epigene or Exogenic:**
  Exogenic (also known as exogenetic) refers to external processes and phenomena that occur on or above the Earth's crust. The tidal force of the Moon

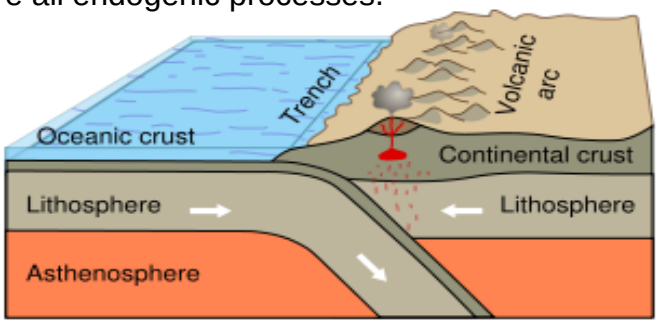
and radiation from the Sun are all exogenic. Weathering effects and erosion are also exogenic processes.





- **Hypogene or Endogenic:**

  Endogenic (also known as endogenetic) is a geologic term that refers to internal processes and phenomena that occur beneath the Earth's surface, i.e. originates within the earth's crust - or any other celestial body. Plate tectonics, earthquakes and volcanoes are all endogenic processes.



- **Extraterrestrial:**

  The topographic effects of the impact of comets and meteorites (piece of rock or metal that has reached the earth's surface from outer space) are termed extraterrestrial, which means from beyond the limits of earth's domain.





Different Geomorphologic Processes

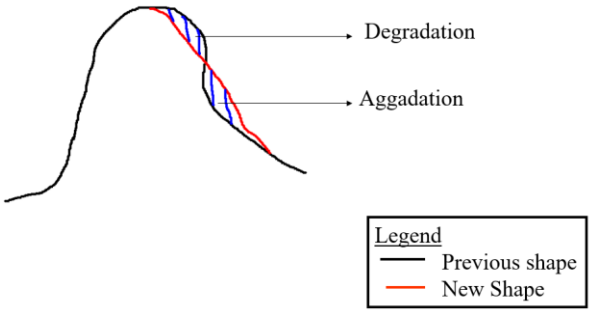
A. Epigene or Exogenic Processes:
    I. Gradation:
        a. Degradation:
            i. Weathering
            ii. Mass wasting or gravitative transfer
            iii. Erosion (including transportation) by
                1. running water
                2. ground water
                3. waves, currents, tides and tsunami
                4. wind
                5. glaciers
        b. Aggradation by:
                1. running water
                2. ground water
                3. waves, currents, tides
                4. wind
                5. glaciers
        c. Work of Organisms including man
B. Hypogene or Endogenic Processes:
                1. Diastrophism
                2. Volcanism
C. Extraterrestrial Processes:
                1. Fall of meteorites

Notes on Different Geomorphic Processes

- **Gradation:**

  It includes all those processes that tend to bring the surface of the lithosphere (the rocky crust of the earth). Gradation process belongs to two categories.

  a. Degradation: Level down
  b. Aggradation: Level up



- **Weathering:**

  This may be defined as the changes that take place in the minerals and rocks at or near the surface of the earth in response to the atmosphere, to water and to plant and animal life. This is a static process and does not involve the removal or seizure of materials by a transporting agency.



Weathering of granitic rocks may result in the formation of angular fragments along joint planes or rounded forms with pressure release.

Here a combination of mechanical and chemical weathering processes has resulted in the formation of a very large weathering pit (note person lying in it for scale) in Mt. Barcroft Granodiorite below White Mountain Peak. Felsenmeer surrounds this unusual boulder.

Mechanical Weathering



Frost wedging - water expands when it freezes.

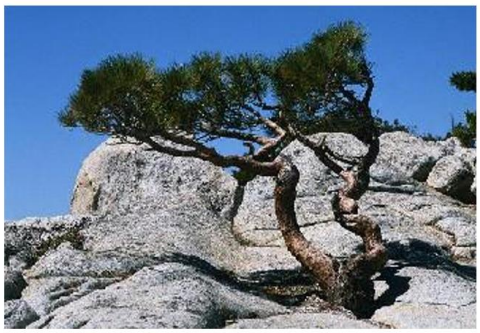
Mechanical Weathering



Exfoliation or unloading caused by expansion of rock due to uplift and erosion; removal of pressure of deep burial.

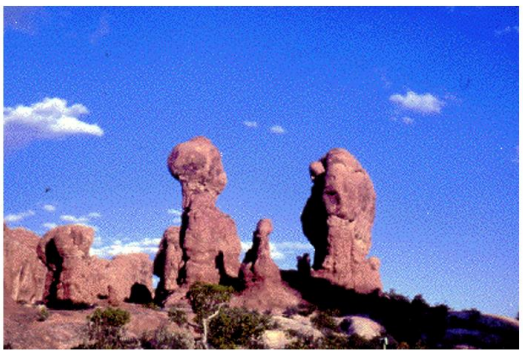
Thermal expansion - repeated daily heating and cooling of rock.

Mechanical Weathering



Organisms can assist in breaking down rock into sediment or soil.

Mechanical Weathering



The Wind -- Mechanical Weathering in Action!

Chemical Weathering



Limestone and ***marble*** contain calcite and are soluble in acidic water

Note that the urn and tops of ledges are heavily weathered, but the inscriptions are somewhat sheltered and remain legible.

Chemical Weathering



Georgia Red Clay" derives its color from the oxidation of iron bearing minerals.

Chemical Weathering

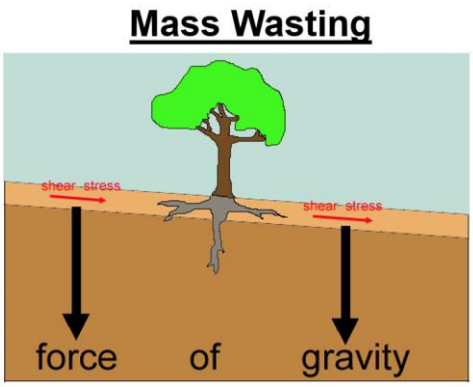


Feldspar alters to clay (kaolinite) plus dissolved materials (ions).

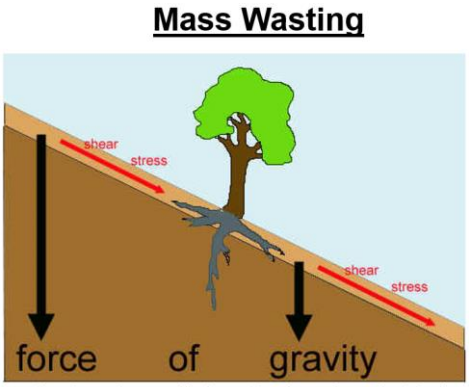
$KAlSi_3O_8 + H_2O \rightarrow Al_2Si_2O_5(OH)_4 + K^+ + SiO_2 + H_2O$

- **Mass Wasting:**

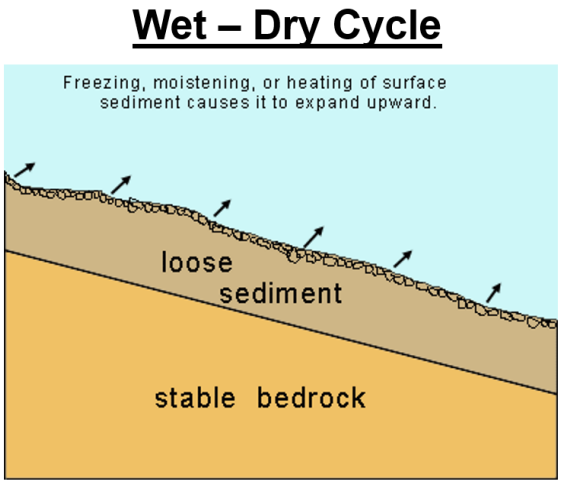
  It involves the mass transfer of the masses of rock debris down slopes under the direct influence of gravity. Mass wasting is usually aided by the presence of water but the water is not in such an amount so that it can be considered as a transporting medium. (We can think that the process is initiated by the action of water but the material is actually carried by the action of gravity)

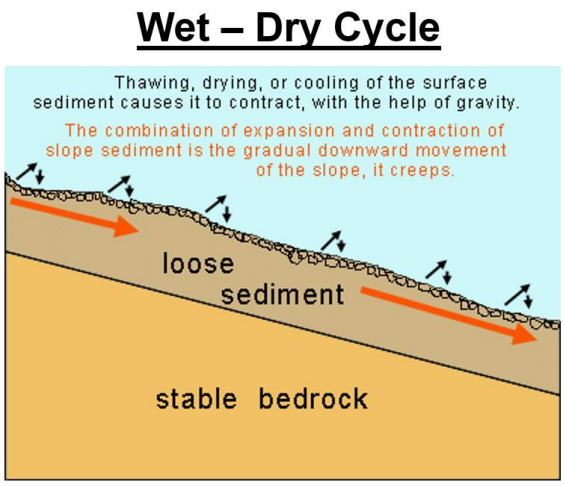


Mass wasting is unlikely on this illustration because little shear stress is being produced by gravity.



Mass wasting is much more likely on the slope shown in this diagram because the slope is more in line with the force of gravity than in the top diagram.

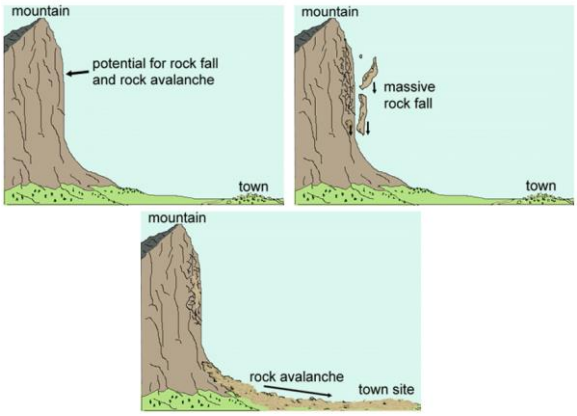




Mass Wasting - Example



Falls – Mass Wasting



Examples - Falls

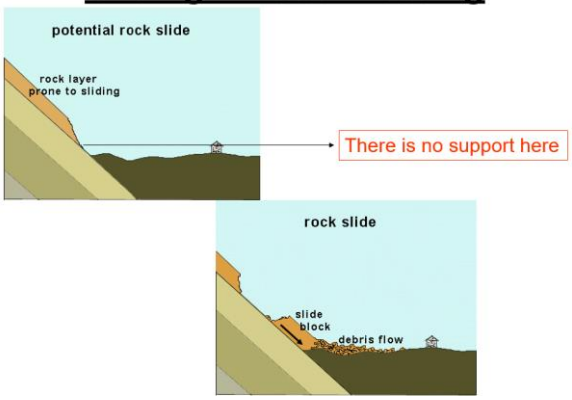


The photograph to the left shows the highest peak in the Peruvian Andes, Nevado Huascaran.

In 1970, and earthquake triggered a massive rock fall event that originated from the barren area near the top of the peak.

It quickly became a rock avalanche that flowed across a broad valley, filling it with rock and debris to depths of 300 feet.

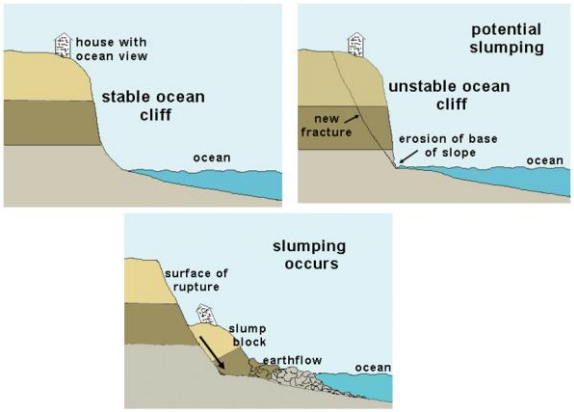
Sliding – Mass Wasting



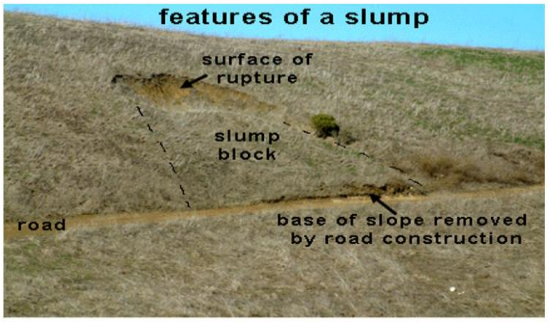
Example - Sliding



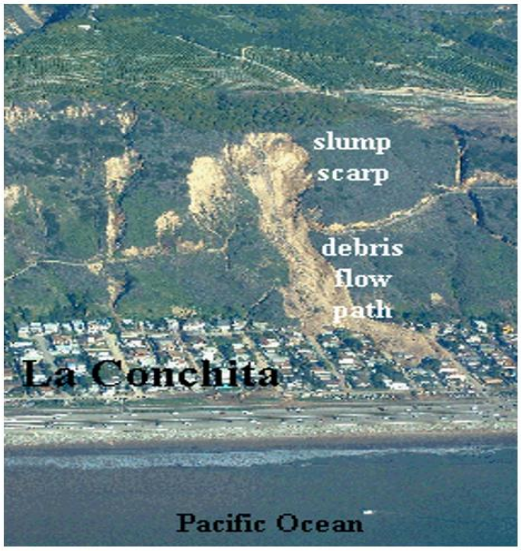
Slump



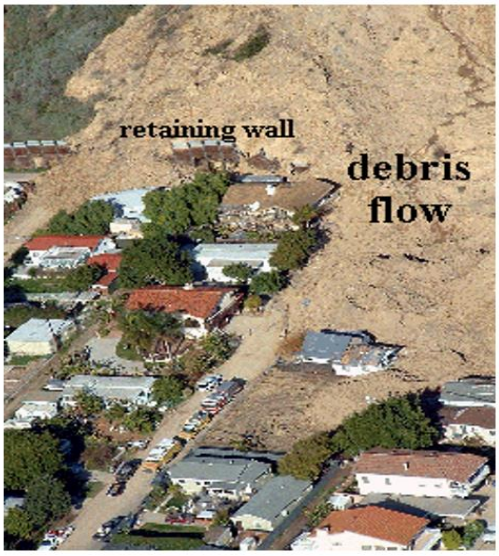
Example - Slump



Example - Slump



Example - Slump



Mass Wasting – Bangladesh Perspective

Composition of Our Hills



Composition of Our Hills



Composition of Our Hills



Composition of Our Hills



Some Land Slide Pictures



Some Land Slide Pictures



Some Land Slide Pictures



Some Land Slide Pictures



- **Impact of Meteorites:**

  The uniqueness of the process lies in the fact that they were produced by the extraterrestrial agents although earth's gravitational attraction was responsible for the fall of meteorites.

- **Topographic Effects of Living Beings:**

  Man made road-cuts and -fills and many other kinds of excavations profoundly modify the earth's surface. Explosives (bombs) may become a distinctive and prevalent type of land form if modern welfare continues.

- **Diastrophism:**

  The process of deformation that produces continents and ocean basins in the earth's crust is known as diastrophism. All actual movements of the earth's solid crust of any kind or degree can be considered as diastrophism.

  The crust movement falls in 2 categories:

  a. Slow movement of plates
  b. Sudden movements (earthquakes)

- **Volcanism:**

  It includes all sorts of volcanic activities together with the movement of the molten rock or magma into or towards the earth's surface.