INTRODUCTION TO PHYSICAL GEOGRAPHY

GE:140

INTRODUCTION

- Physical geography is a discipline that is part of a much larger area of understanding called **geography**.
- Most individuals define geography as a field of study that deals with **maps**.
- This definition is only partially correct. A better definition of geography may be ***the study of natural and human constructed phenomena relative to a spatial dimension***.

- The discipline of geography has a history that stretches over many centuries.
- Over this time period, the study of geography has evolved and developed into an important form of human scholarship.
- Examining the historical evolution of geography as a discipline provides some important insights concerning its character and methodology
- These insights are also helpful in gaining a better understanding of the nature of physical geography.

WHAT IS PHYSICAL GEOGRAPHY

- Physical geography is “the spatial analysis of the physical elements and processes that make up the environment: energy, air, water, weather, climate, landforms, soils, animals, plants, microorganisms, and Earth itself”
- Physical geography also examines the interrelationships of these phenomena to human activities. This sub-field of geography is academically known as the **Human-Land Tradition**. This area of geography has seen very keen interest and growth in the last few decades because of the acceleration of human induced environmental degradation.

SCOPE OF PHYSICAL GEOGRAPHY

- Physical geography encompasses elements of many disciplines, including climatology, meteorology, oceanography, geomorphology (study of landforms), soil science, biogeography and ecology (distribution and ecology of life), hydrology, and natural resources.
- Thus, physical geography's scope is much broader than the simple spatial study of nature. It also involves the investigation of how humans are influencing nature.

- **Geomorphology** - studies the various landforms on the Earth's surface.
- **Pedology** - is concerned with the study of soils.
- **Biogeography** - is the science that investigates the spatial relationships of plants and animals.
- **Hydrology** - is interested in the study of water in all its forms.
- **Meteorology** - studies the circulation of the atmosphere over short time spans.
- **Climatology** - studies the effects of weather on life and examines the circulation of the atmosphere over longer time spans.

- **Geology** - studies the form of the Earth's surface and subsurface, and the processes that create and modify it.
- **Ecology** - the scientific study of the interactions between organisms and their environment.
- **Oceanography** - the science that examines the biology, chemistry, physics, and geology of oceans.
- **Cartography** - the technique of making maps.
- **Astronomy** - the science that examines celestial bodies and the cosmos.

Topic 1: Earth Processes and Landforms

- 1.1 Internal processes and movements
- 1.2 Rock forming processes
- 1.3 Geomorphic processes and landforms
- 1.4 Desert processes and landforms
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1.1 Internal processes and movements

- **Internal Processes**
- - a **process** that shapes the earth with forces from the **interior** of the earth e.g. plate tectonics, volcanic formations, earthquakes,

. Note: **Internal processes** are known as endogenetic **processes**

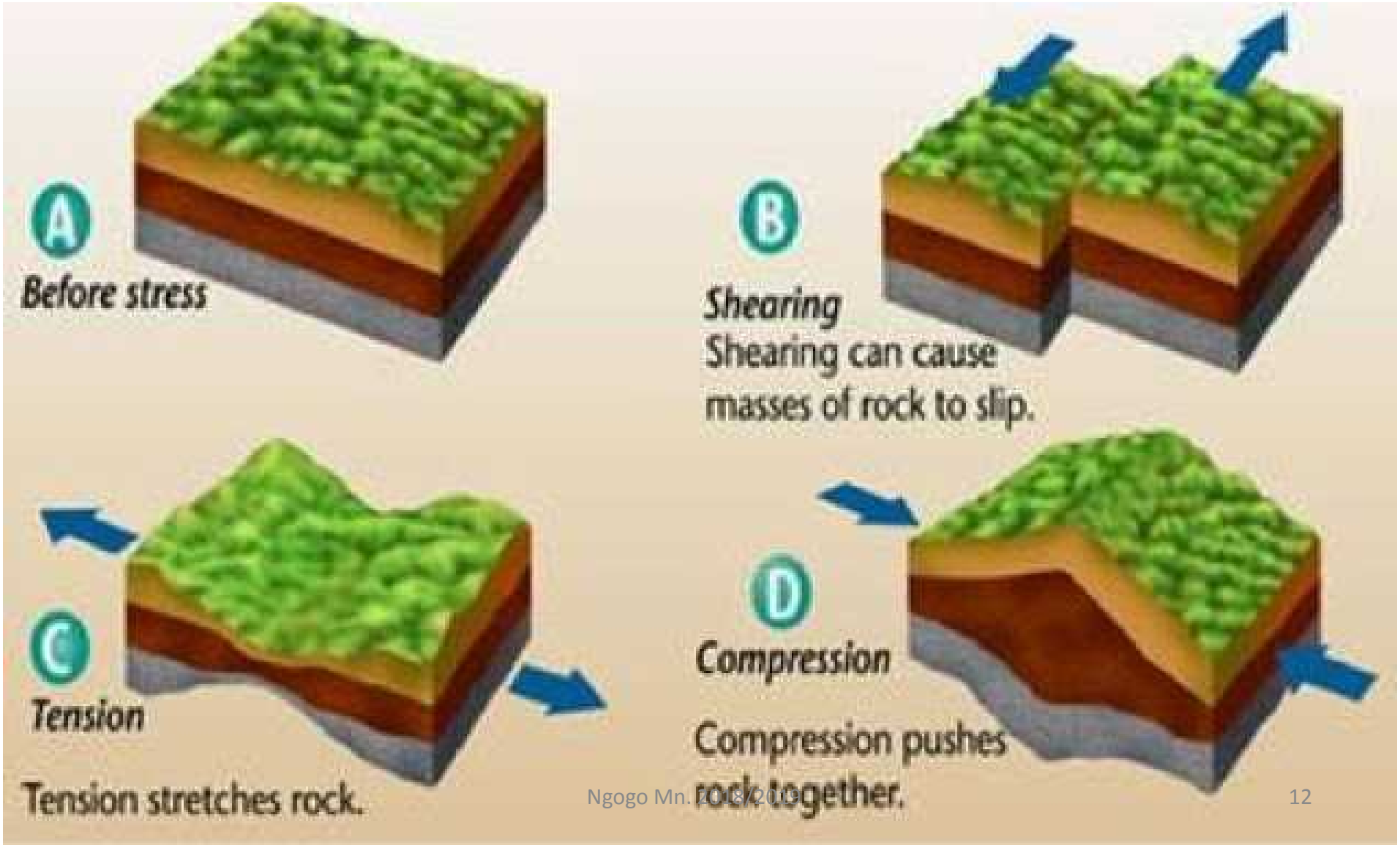
- Internal processes operate within Earth, drawing energy from heat
- In general, they are building forces, increasing relief of land surface
- The three forces are compressional force, tensional force and shear/lateral force.

Forces in Earth's Crust

- A force that acts on rock to change its shape or volume is stress
- 3 types of stress acting on rock layers

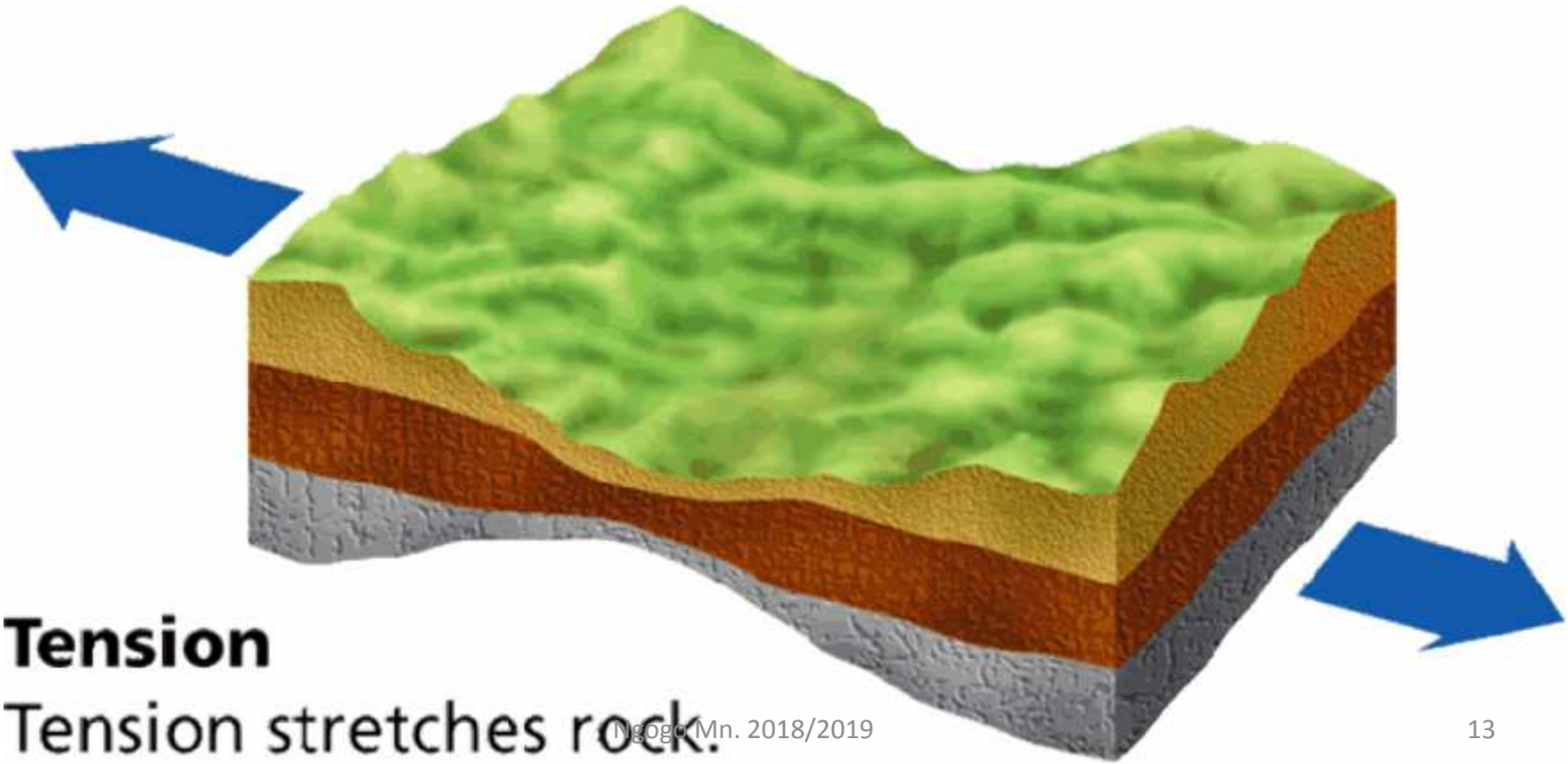
- **Tension** pulls on the crust
- **Compression** squeezes rock
- **Shearing** pushes a mass of rock in two opposite directions

Types of Stresses



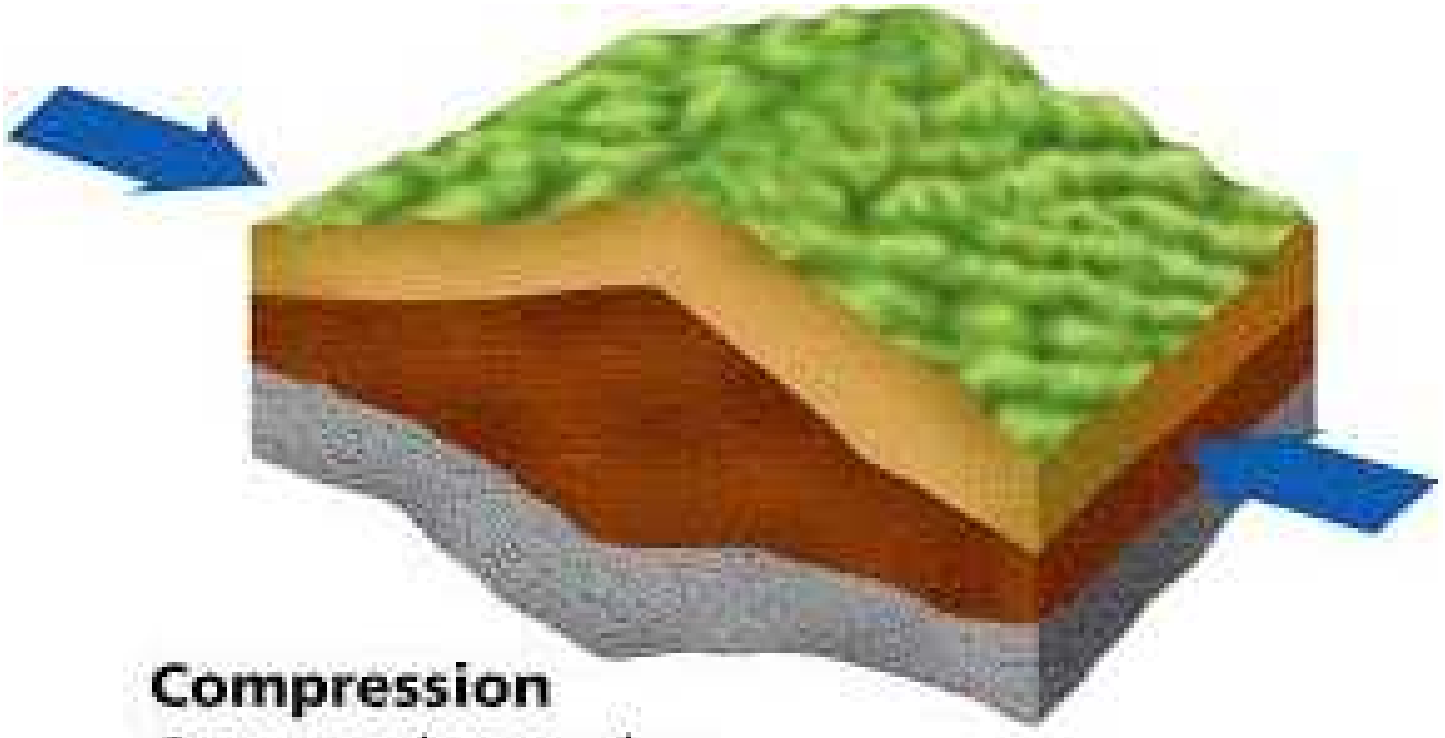
Tension Force

- Tension pulls on the crust, stretching rock so that it becomes thinner in the middle. (divergent boundaries)



Compression Force

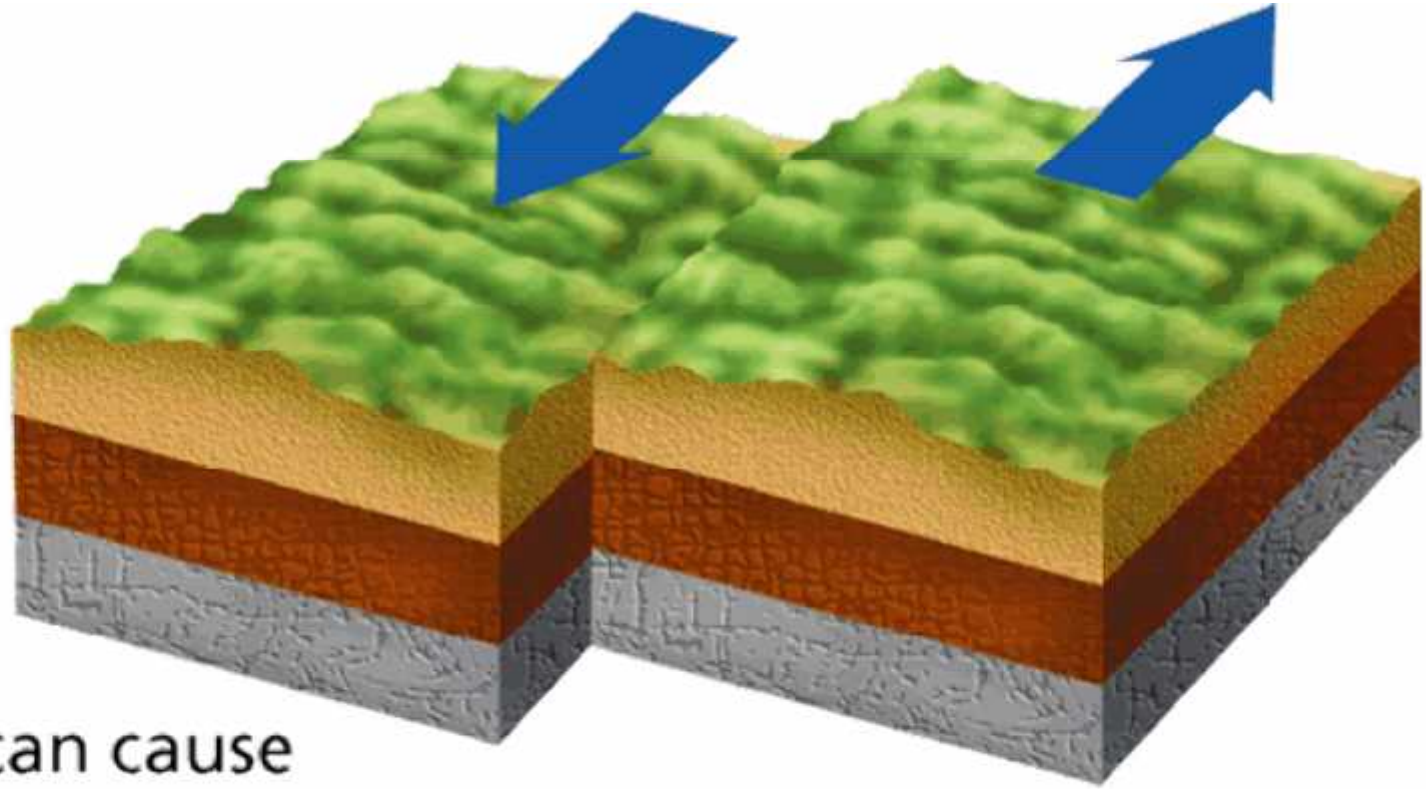
- Compression squeezes rock until it folds or breaks. (convergent boundaries)



Compression
Compression pushes rock together.

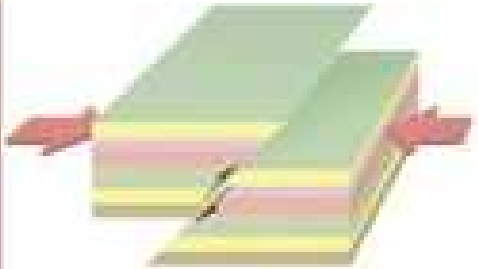
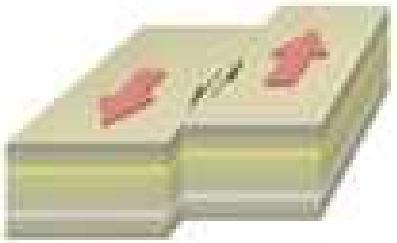
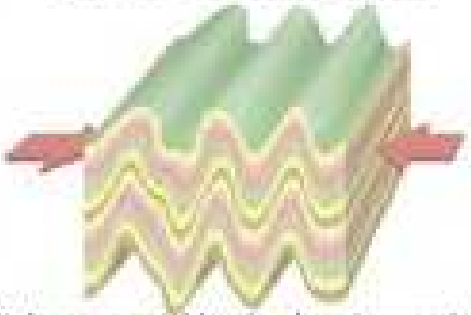
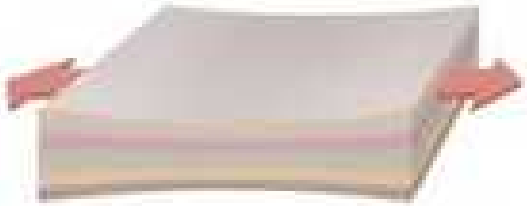
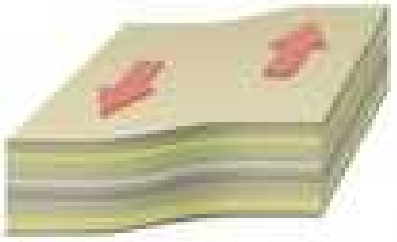
Shearing Force

- Shearing pushes a mass of rock in two opposite directions. (transform boundaries) Rock breaks and slips apart or changes shape.



Shearing
Shearing can cause masses of rock to slip.

How Rocks Respond to Differential Stress

Type of stress	COMPRESSION (Compression causes shortening)	TENSION (Tension causes stretching)	SHEAR (Shear distorts rock)
At shallow depths rocks exhibit brittle fracture	 At shallow depths shortening occurs by brittle deformation along faults where one rock mass is thrust over another.	 At shallow depths tensional stresses cause rocks to fracture and pull apart.	 At shallow depths shear stress causes offsets in crustal blocks along faults.
At deeper crustal depths rocks deform by ductile flow	 At deeper crustal levels where temperatures are high, compressional forces squeeze and fold rock masses.	 At deeper crustal levels where temperatures are high, tensional forces stretch and elongate crustal materials by ductile flow.	 At deeper crustal levels where temperatures are high, shear stress distorts rock masses by ductile flow, usually along shear zones.

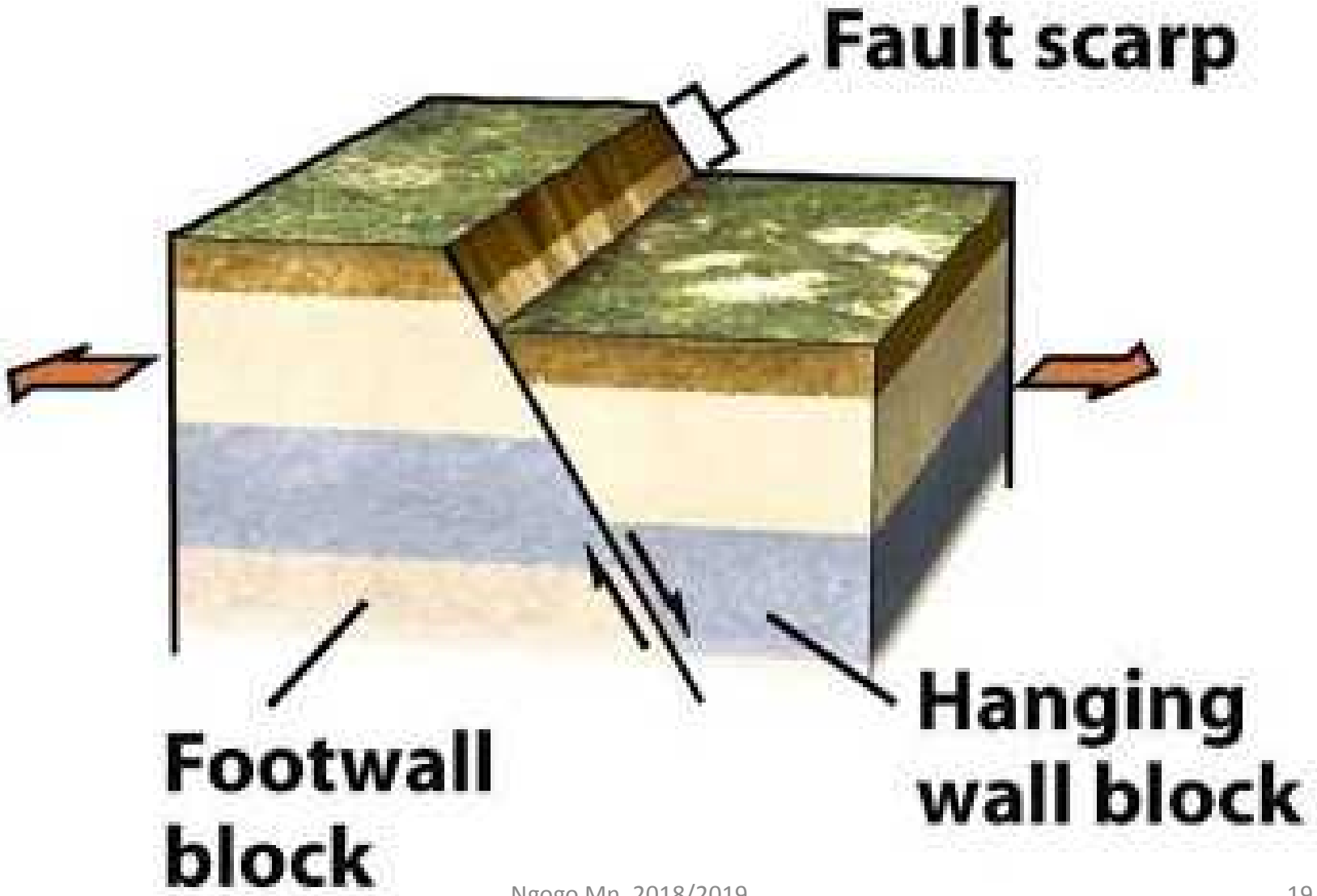
Faulting

- When enough stress builds up in rock, the rock breaks, creating a **fault**.
- **A fracture** is a break in the rock.
- **A joint** is a fracture where rock movement doesn't occur.
- A fault is a break in the rock of the crust where rock surfaces slip past each other.
- Most faults occur along plate boundaries, where the forces of plate motion push or pull the crust so much that the crust breaks.

Three main types of faults:

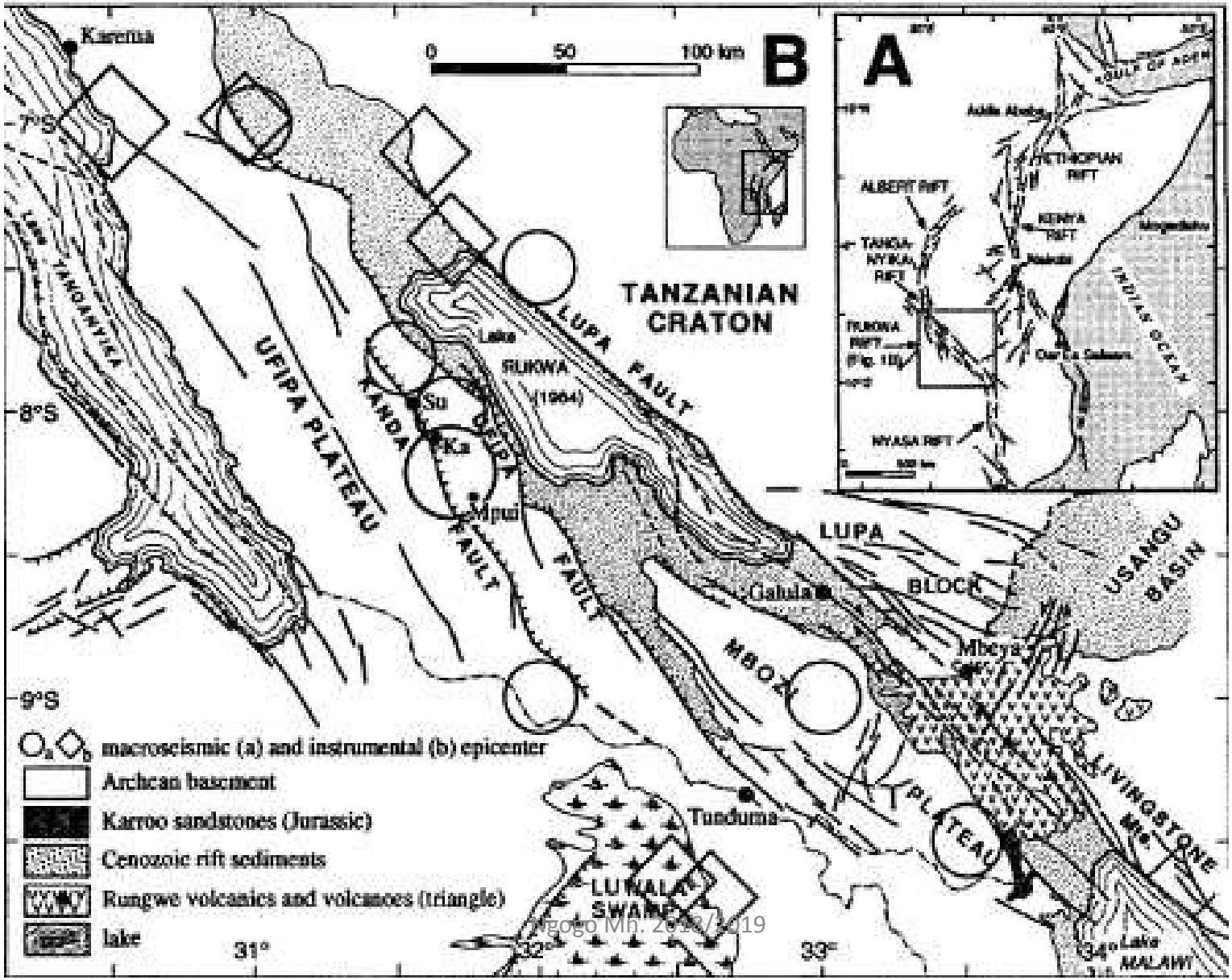
- **1. normal faults-**
- Tension causes a normal fault. Divergent boundary.
- In a normal fault, the fault is at an angle, and one block of rock lies above the fault while the other block lies below the fault.
- The block of rock that lies above is called the **hanging wall**. The rock that lies below is called **the footwall**.

Normal Fault

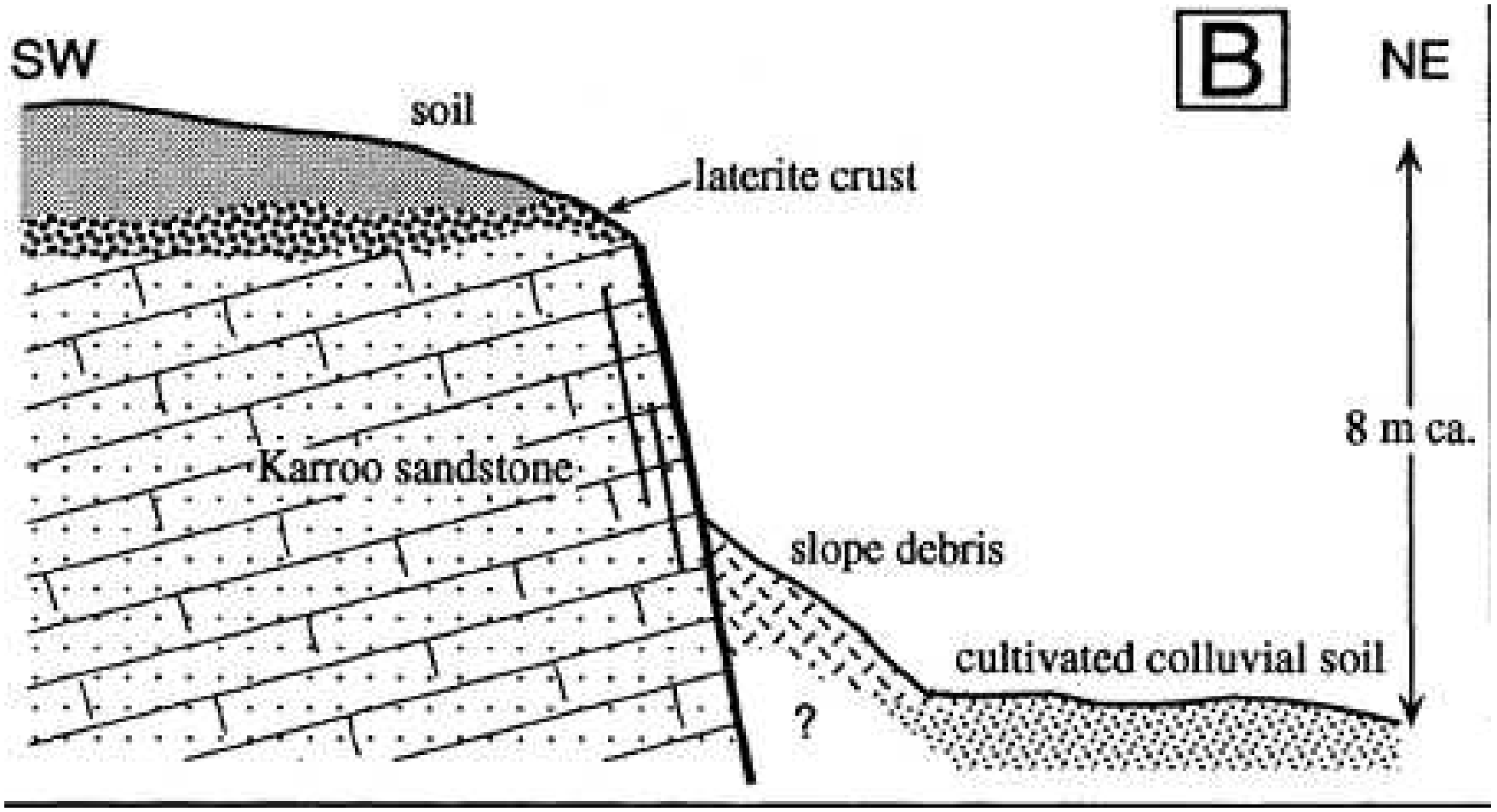


Example of a normal fault at Kilve Beach - Devon - UK

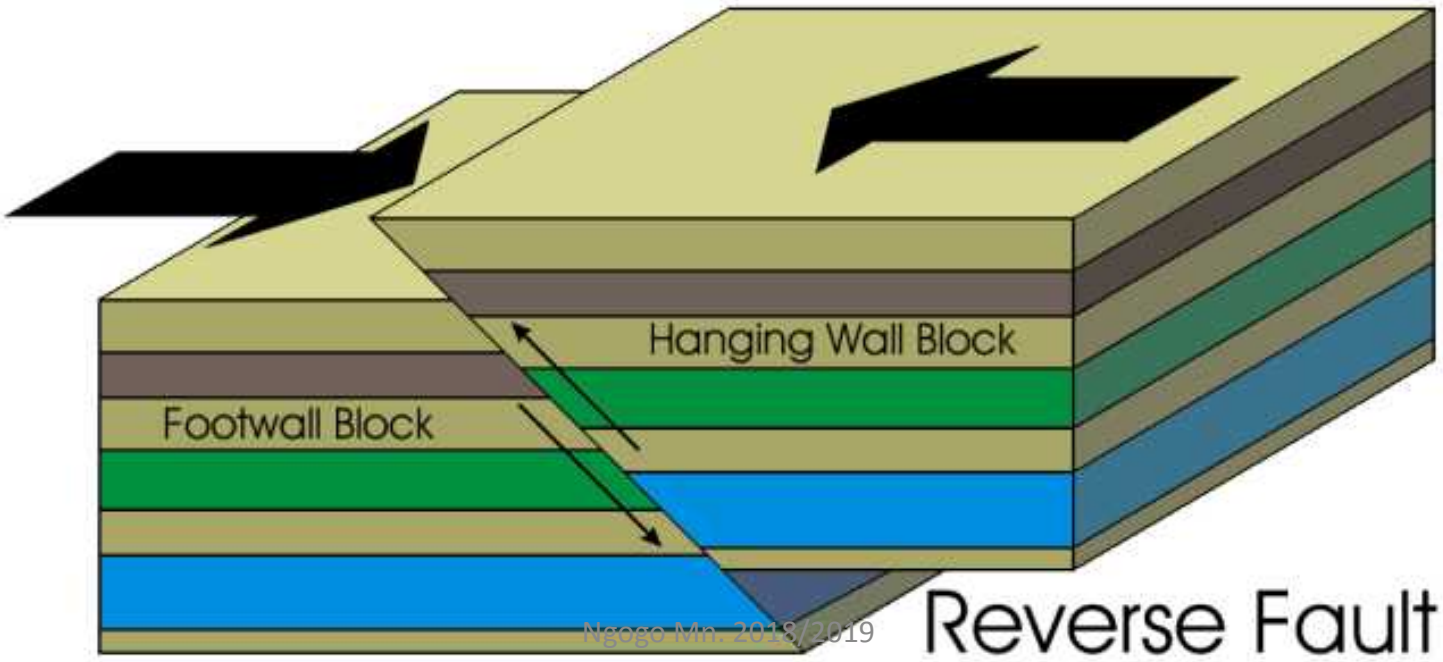
Kanda Fault in Tanzania(West of the Rukwa Rift)



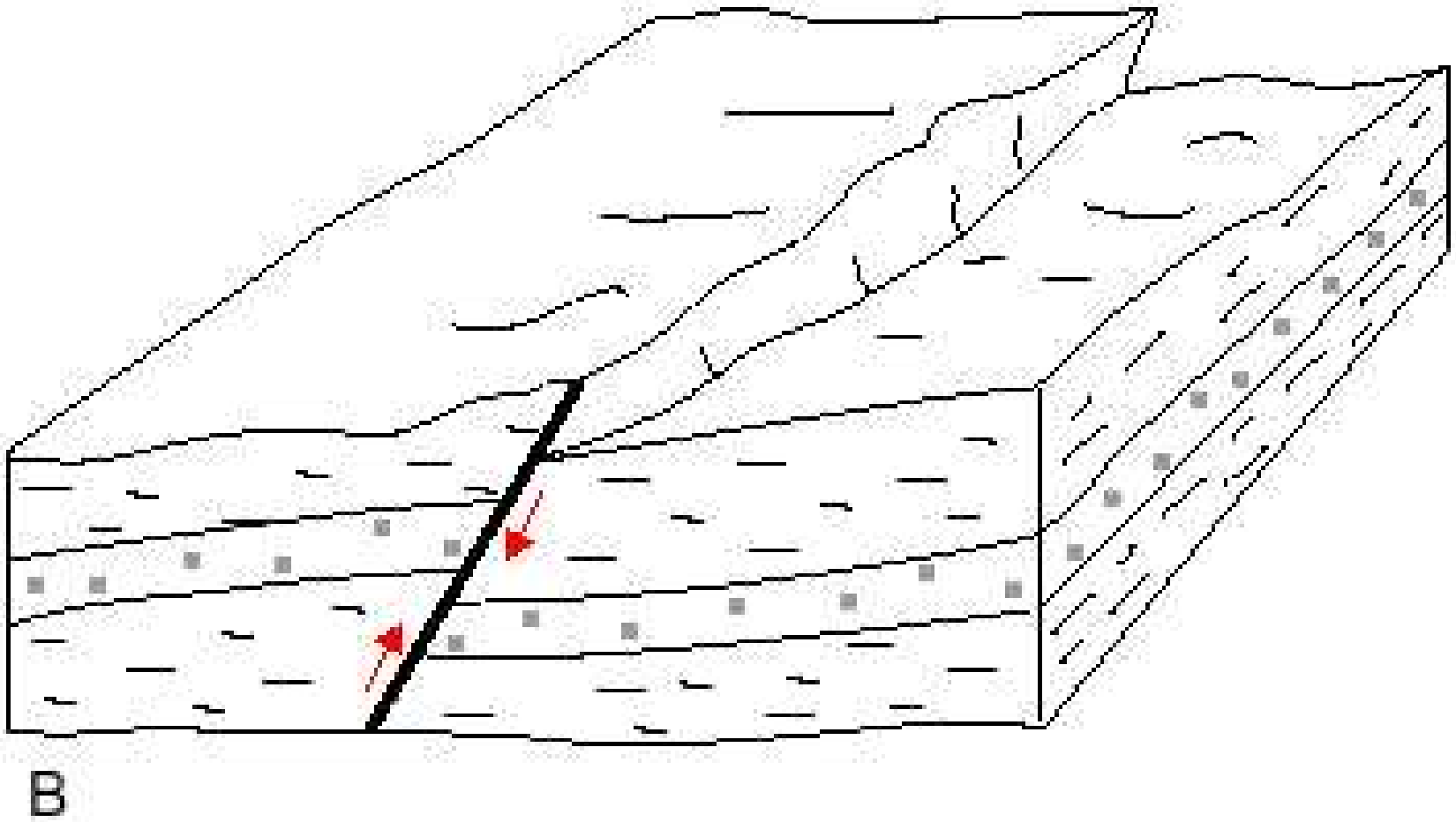
View of the Kanda fault at NE Sumbawanga



- **2. reverse faults- (Compressional fault)**
- Compression causes reverse faults. Convergent boundary. (hanging wall slips upwards along the fault)
- A reverse fault has the same structure as a normal fault, but the blocks move in the opposite direction. Vertical rock motion. e.g. South Oregon USA



A reverse Fault



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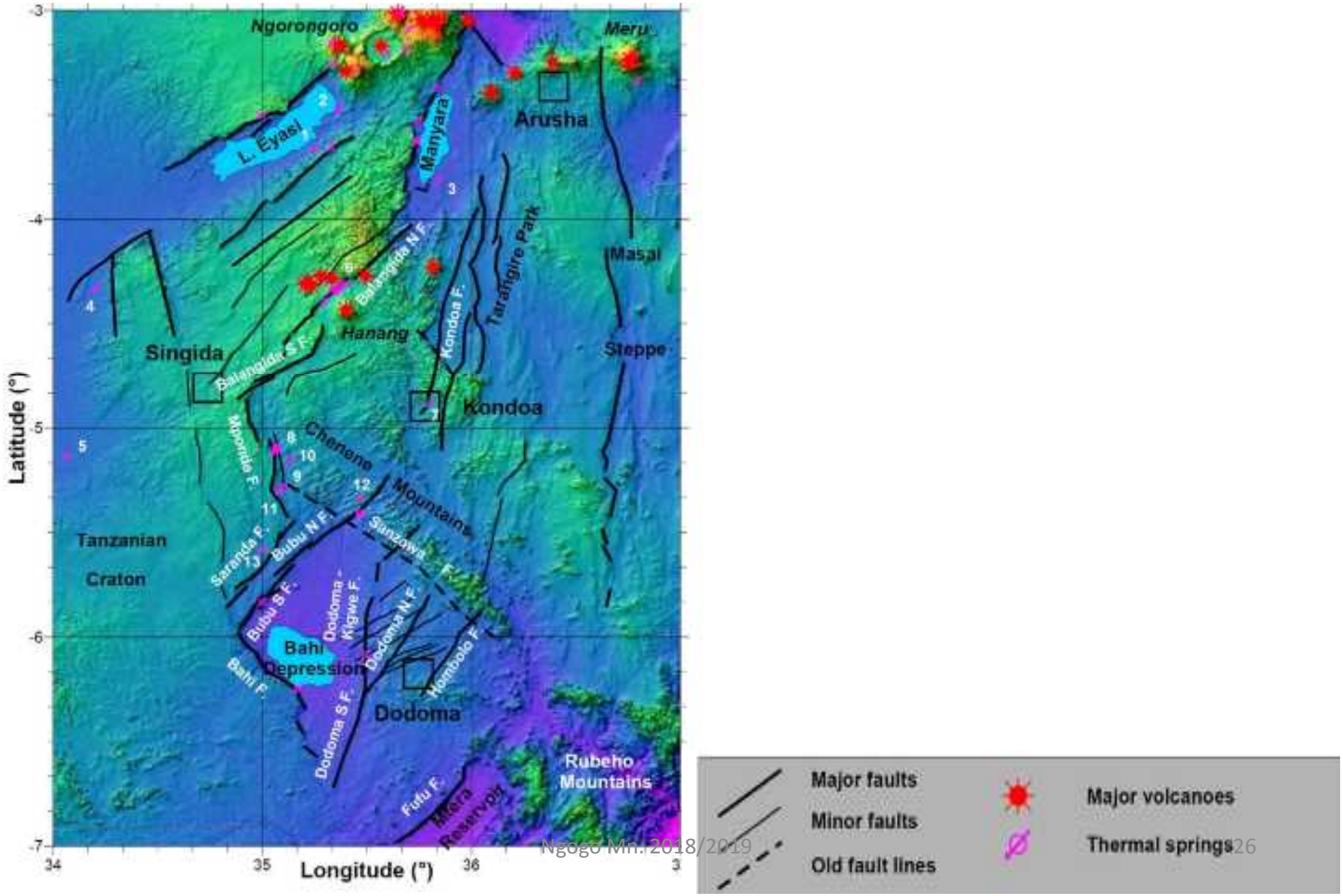
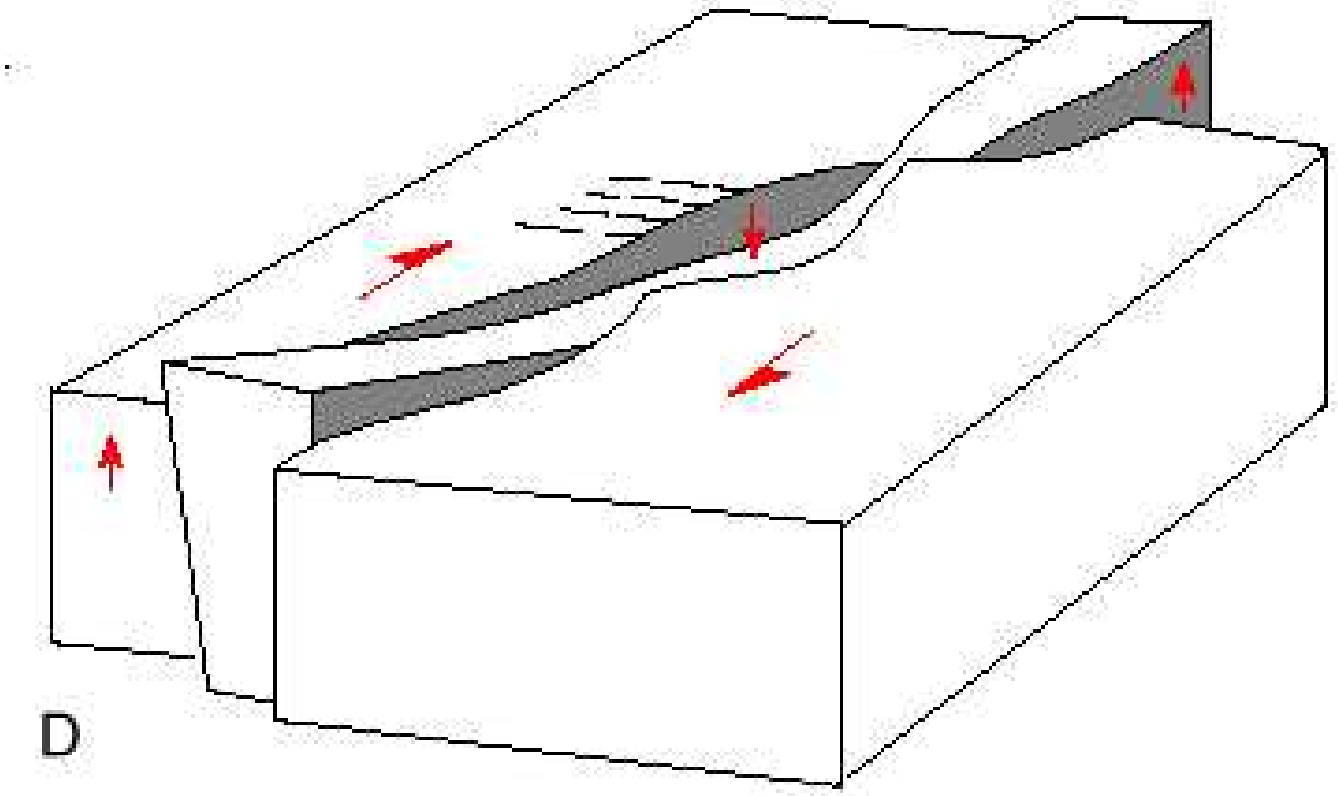
Reverse fault zone, Ketobe Knob, Utah at Colorado USA

Areas with fault features in Tanzania



- 3. strike-slip faults-
- Shearing creates strike-slip faults. Transform boundary.
- In a strike-slip fault, the rocks on either side of the fault slip past each sideways, with little up or down motion. Horizontal rock motion. Ex. San Andreas Fault.

- The Shear fault is also known as a Wrench Fault
- It is also formed when the two blocks slide passed other instead of colliding.
- It involves the horizontal displacement
- Good examples of Wrench faults are the San Andreas fault, Aswa valley in northern Uganda Great Glen of Scotland, Great Alpine Fault of New Zealand



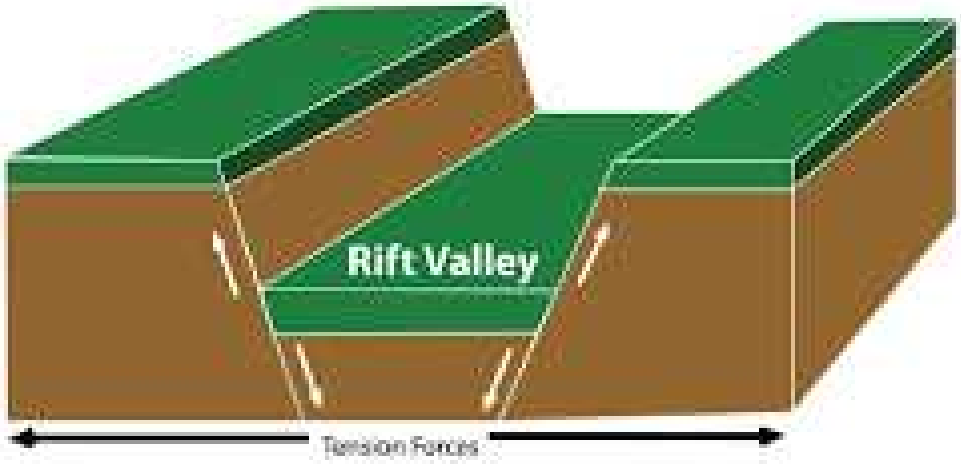
This block diagram of a wrench-fault zone shows that vertical movement is often very complex. Faults may appear to be normal or reverse along the fault zone, and fault reversals and scissoring are common; horizontal displacement is greater than these vertical complications

San Andreas Fault (US)

FAULTING AND LAND FORMS

- 1. Rift Valley

- An elongated trough or depression which is bordered by in-facing fault scarp.



Theories supporting the formation of rift valley

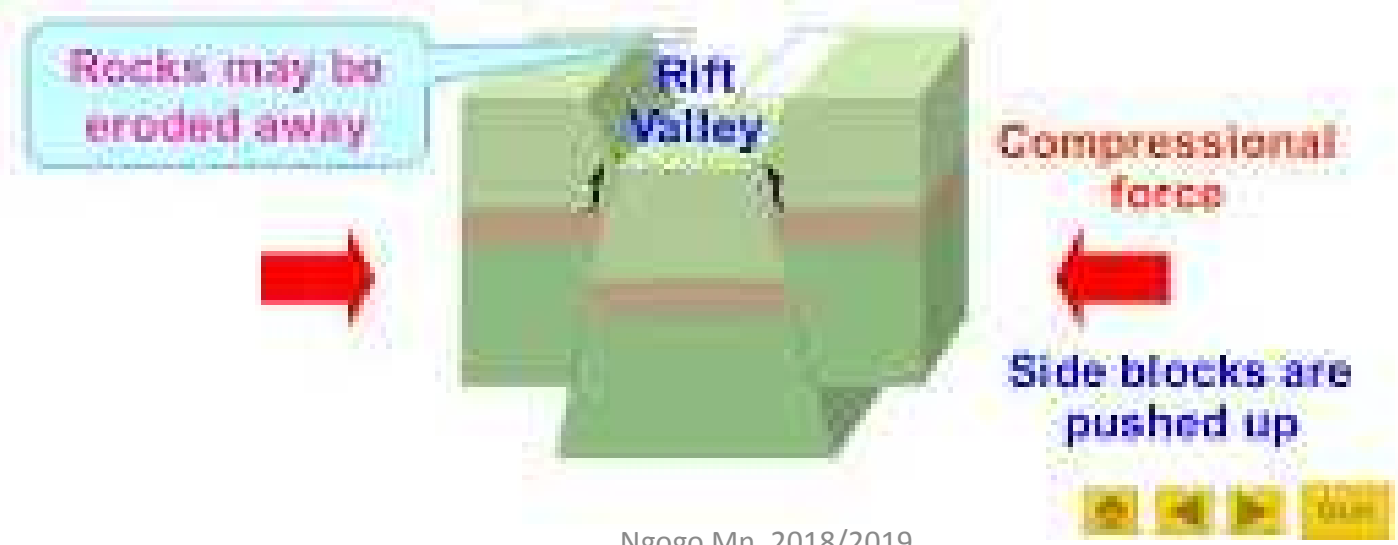
- 1. Tensional force theory

- The theory holds that rift valley is formed due to tensional force
- The force act on the crust resulting into development of parallel fault lines
- As the forces pull away, the central block become loose and then sinks or subside as a trough rift valley. E.g. Kenya (G.E.A.R.V), Middle Rhine between Vosges etc

Kenyan section in the Great East African Rift Valley

2. Compressional Force Theory

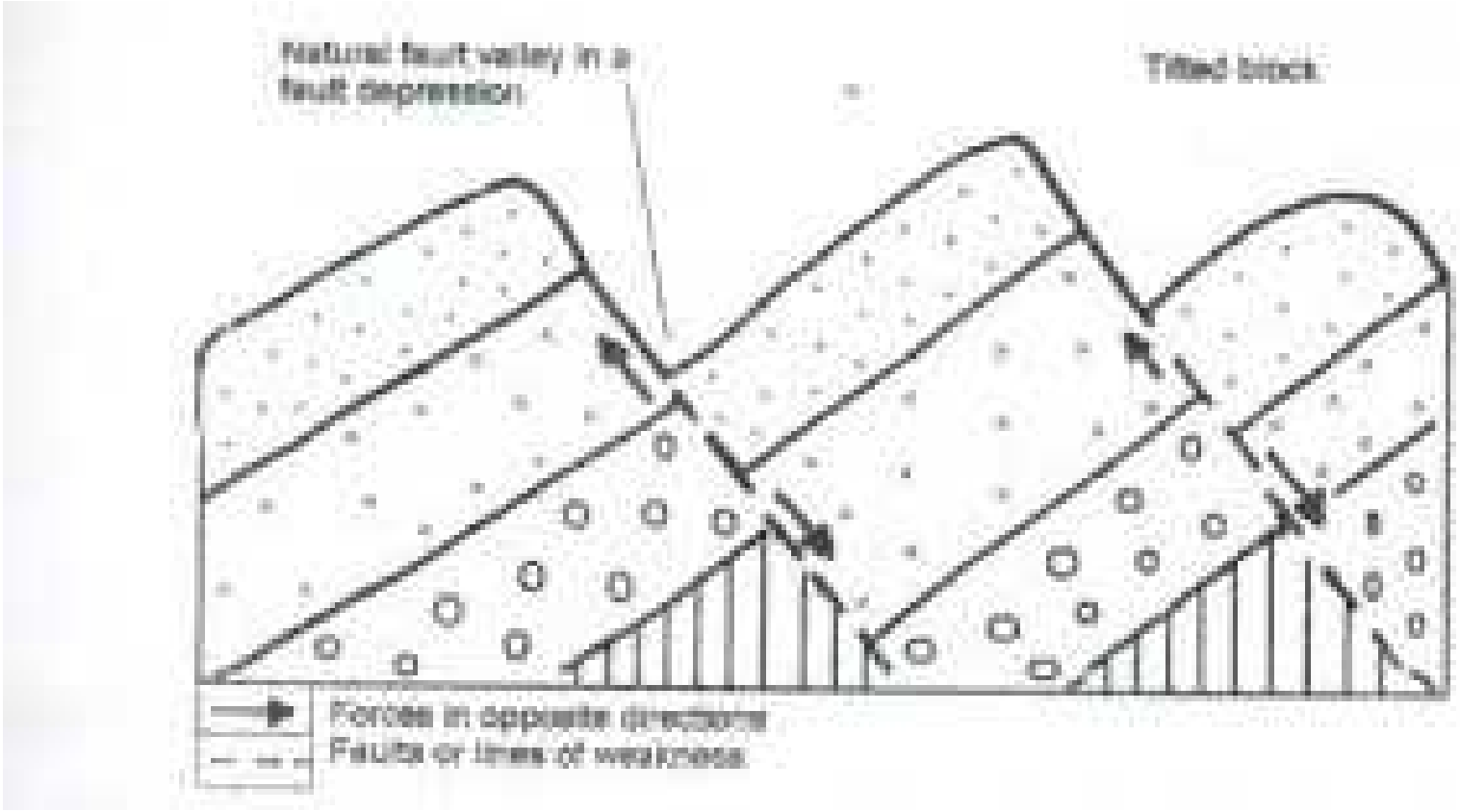
- Suggests that a rift valley resulted from compressional forces
- The side parts are up thrusted leaving a trough bordered by steep sides-rift valley



Differential in uplift theory

- Contends that r. valley might have formed from a tilted block.
- Followed by the uplifted of land whereby the central block was lifted at a slower pace compared to the side blocks.
- The central block remained as a depression bordered by in-facing steep sides
- Hence, a rift valley is also called a step-faulted rift valley as it is characterized by the sides which are like steps formed due to differential in uplift.

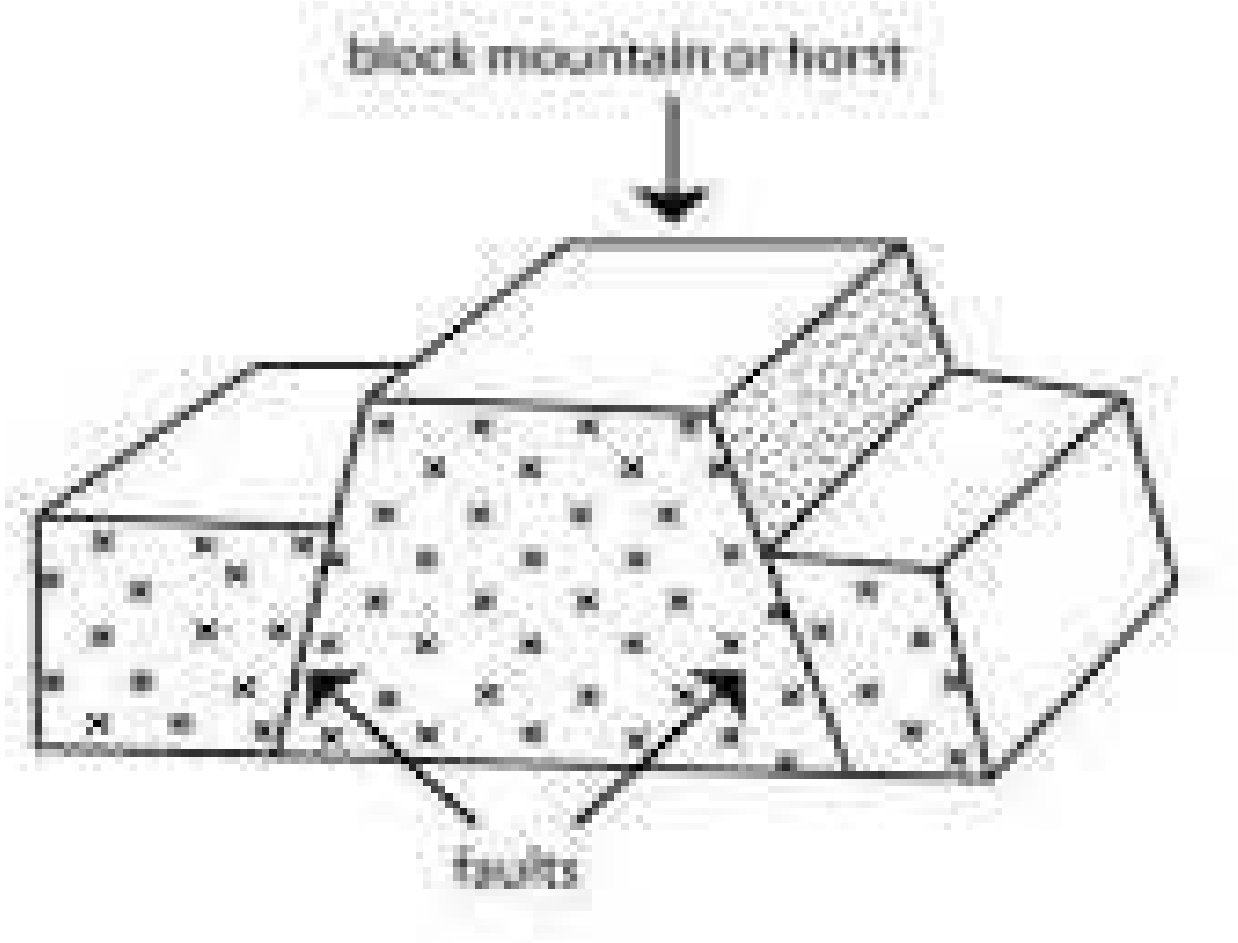
Tilted block resulting into a Rift Valley



Block Mountain or Horst

- It is an upland which is bordered by a fault line on one or more side.
- It may be formed due to uplift or sinking of the crust on either side of a pair of faults or the bodily uplift of a mass between them.
- E.g. Usambara, Uluguru in TZ, Ruwenzori in Uganda Vosges in France and Black forest mountain in Germany are good examples

BLOCK MOUNTAINS



Usamabara Mountains

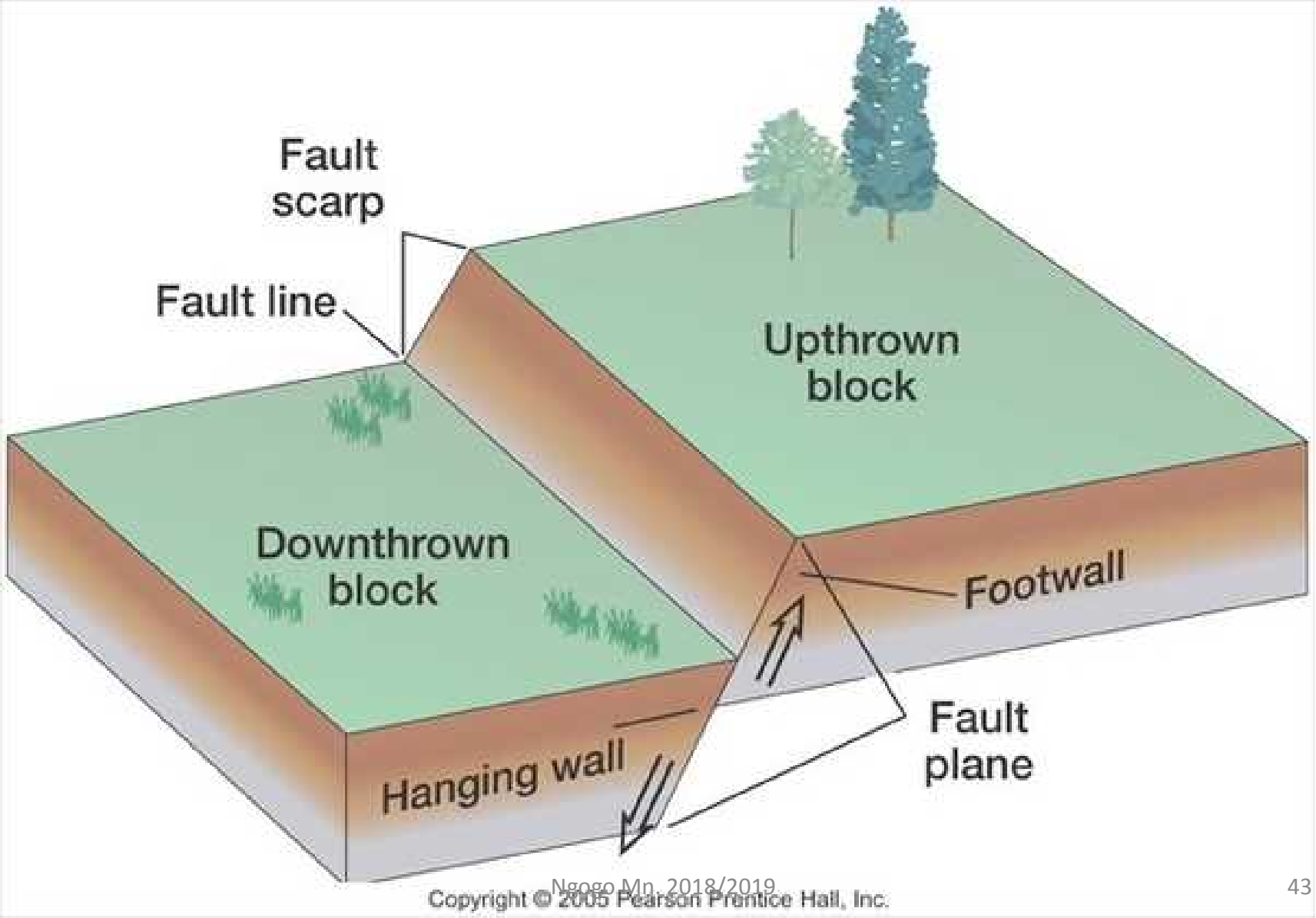
Uluguru Mountains

Vosges Mountains in France

Fault-Scarps and Fault-line Scarp

- It is an escapment or steep slope along a fault or rift valley or block mountain
- Forms due to vertical movement of block along a fault line.
- Development of faults may be followed by either an upward or down ward movement
- E.g. Butiaba-Uganda, Elgeyo-Kenya, Chunya and Manyara in TZ

Formation of Fault-Scarps



Chunya Mbeya

Elgeyo Escarpment

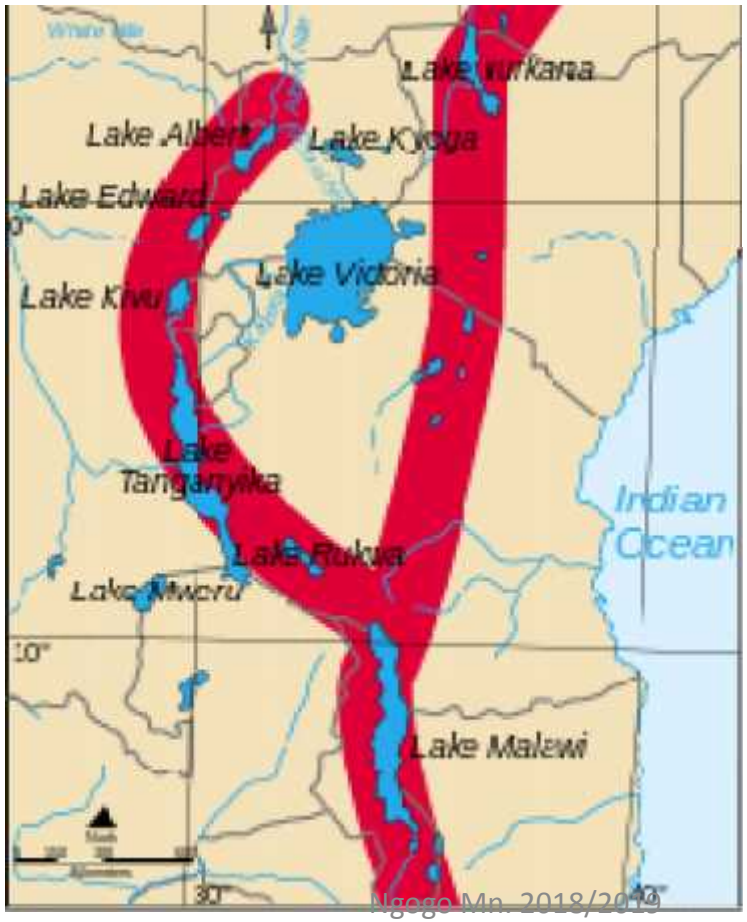
Fault-Guided River Valley

- Is a valley along a fault line cut by a river.
- Sometimes rivers may leave their course and flow along fault line to erode and widen the fault to become a valley where it flows. It may develop a trellis pattern
- E.g. Zambezi river at Batoka Gorge-below the Victoria falls, River Aswa in Uganda and Klein Berg River near Tlbagh in South Africa.

Batoka Gorge-below the victoria falls in Zambia/Zimbabwe

Rift valley lake

- A lake found at the floor of a rift valley



A crack in the G.E.A.R.V

Earth Movements

- The powerful internal forces operating from within the crust are called earth movements. Such movements may be slow and sudden.
- Our earth is unstable, every second some disturbances are taking place in any part of the earth.
- Submergence, volcanic eruption, plate tectonic and ocean floor spreading are commonly cited as earth's crust disturbances.

Causes of the Earth Movements

- The speculation of land forms on the earth surface in different ages of geological times and at different places enforce the geologist and geomorphologist to think over the genetic forces and processes responsible for their origin.
- The forces of the earth movement rest in the crust

How the forces of earth movement came into being

- 1. From time to time certain sections below the earth surface become heated, probably, by heat given off by radioactive elements. This caused expansion which brings about a series of events resulting in the folding of adjacent sections of the rock at the surface.

2. The elevated parts of continental regions are continually denuded and the eroded materials are transported and deposited in the sea.

- Consequently, the continents become lighter and the seas become heavier.
- Thus a slow adjustment takes place by the pushing down the oceanic segment and forcing up the land segment.
- Due to this isostatic adjustment, convectional as well lateral forces are originated in the earth's crust.

Types of the Earth Movement

- The earth movements are determined by magnitude and intensity.
- Their effects may appear in different duration of time
- They are differentiated on the basis of whether they are lifted or depressed parts of the surface or whether they are subjected to lateral stretching or compressions

- On the basis of time, earth movements can be classified as
- 1. Sudden Earth Movements
- 2. Slow or Secular Earth Movements

1. Sudden Earth Movements

- When the effect of the earth-movemnet appears on the surface suddenly or abruptly and they finish in short time
- E.g. Earthquakes and volcanoes
- These movements cause heavy loss of properties and life as due to their sudden occurrence.

2. Slow or Secular Earth Movements

- This type of earth movement continues for longer, more than span of our lives
- The effect of these movements is felt very slowly.
- For example formation of Himalays from the floor of Tythes.

Classification of Secular earth Movements

1) Epirogenic Earth Movements
2) Orogenic Earth Movements

Epirogenic Earth Movements

- The vertical force which causes the upliftment or subsidence of some segment of the earth surface
- Uplifted land = up warping
- Subsidence = down warping
- Continents and oceans are formed from those movements
- Also known as continental building earth movement

2. Orogenic Earth Movements

- The Orogenic from Greek “Oro” meaning Mountain.
- This movement is also known as mountain building earth movement b’se the various type of structural mountains are formed by this movement.
- It is a lateral movement of force causes stretching and tension in the rocks

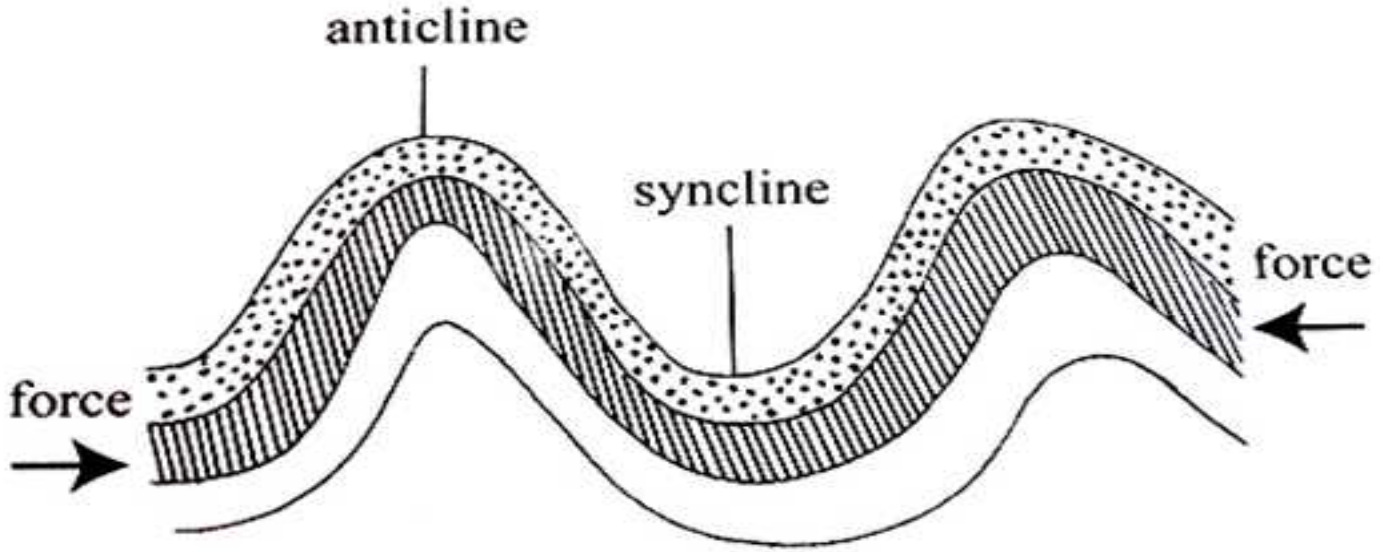
2 kinds of Orogenesis on the basis of movement direction

i. Compressional Force
ii. Tensional Force

Compressional Force

- When the lateral force inside the crust move from opposite direction to common point.
- The rocks are deformed and their area are squeezed.
- Consequently, a wave like structure, called fold is formed
- The up fold is described as crest or anticline
- The down fold as trough or syncline

Up fold and down Fold



The nature of folds vary from region to region due to variation in the amount of compression exerted on the sides of the folds

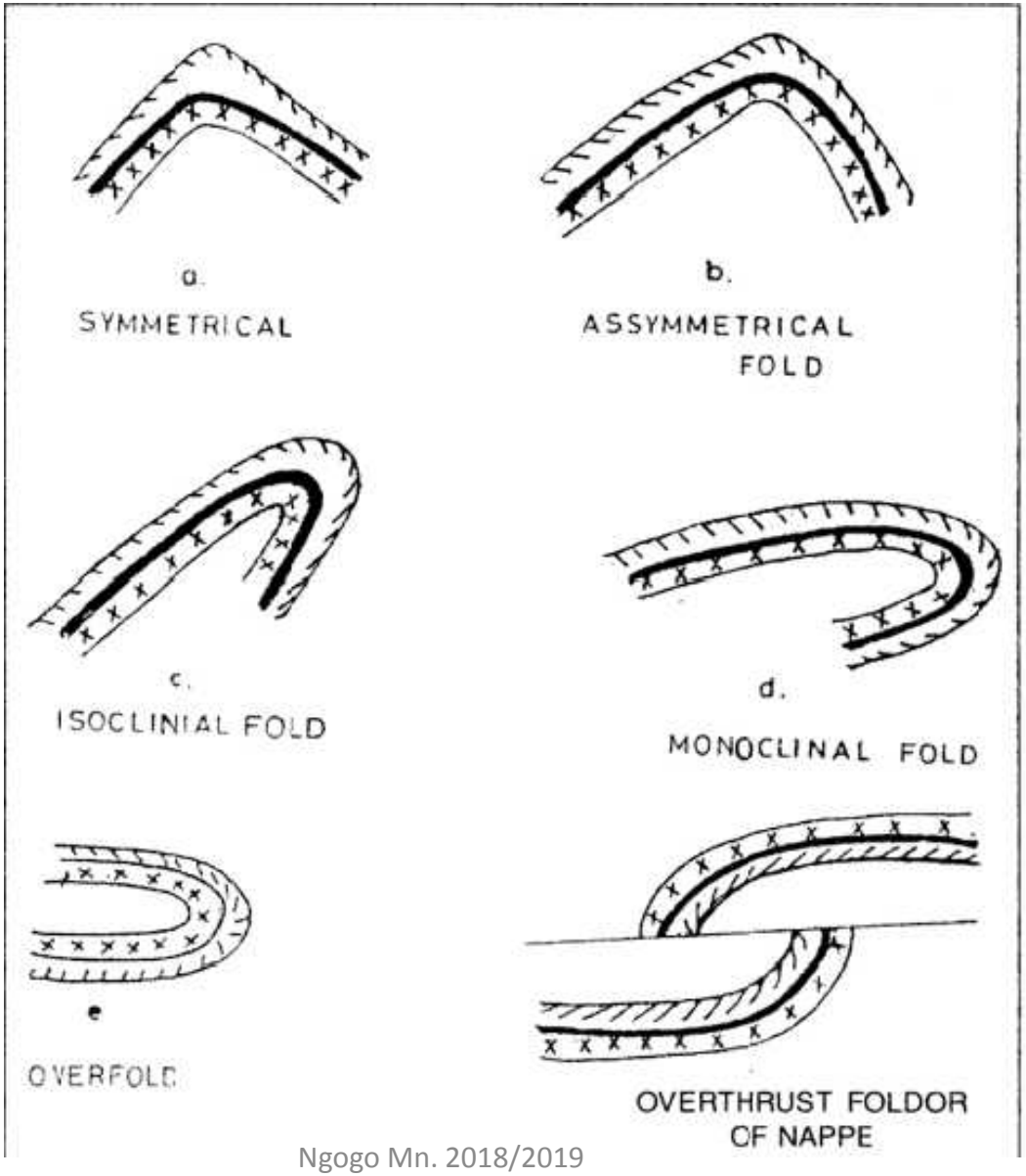
An anticline in Alberta, Canada in the Rocky Mountains

Syncline sidling hill

Kinds of Fold

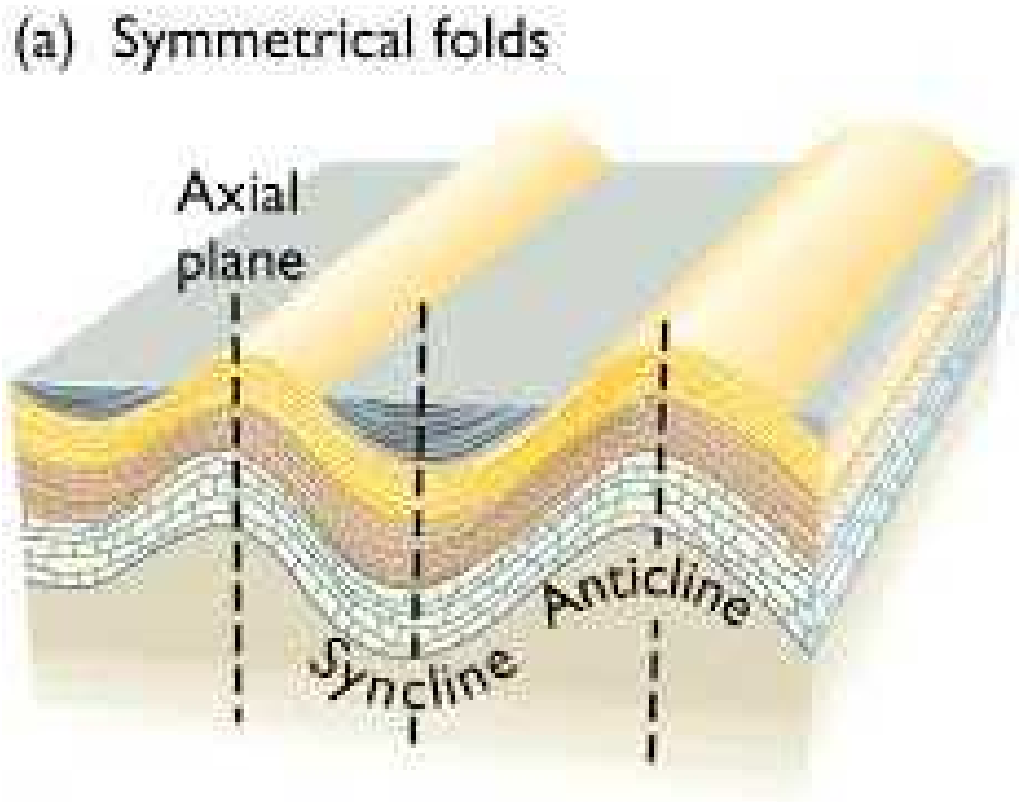
i. Symmetrical folds
ii. Asymmetrical folds
iii. Isoclinal folds
iv. Monoclinal folds
v. Recumbent or over folds
vi. Overthrusts or Nappe folds
vii. Tensional Force

Groups of Folds



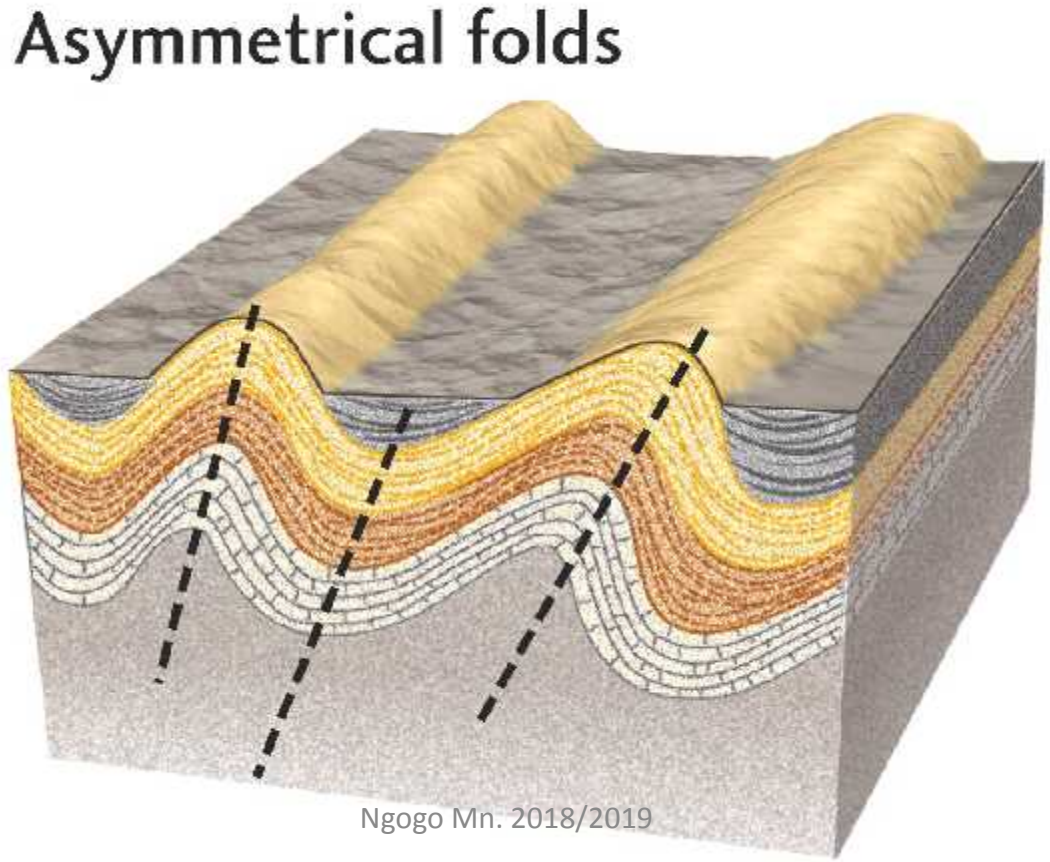
1. Symmetrical Folds

- When the two limbs of the fold dip at equal angle due to compression of same amount of them.



2. Asymmetrical Folds

- It is the type of folds in which the limbs of folds dip at unequal angles. One Limb inclines deeply than the other limb



3. Isoclinal Folds

- The compression force is strong and the two limbs of folds dip in the same direction and become parallel.
- Their axial plane is neither vertical nor horizontal

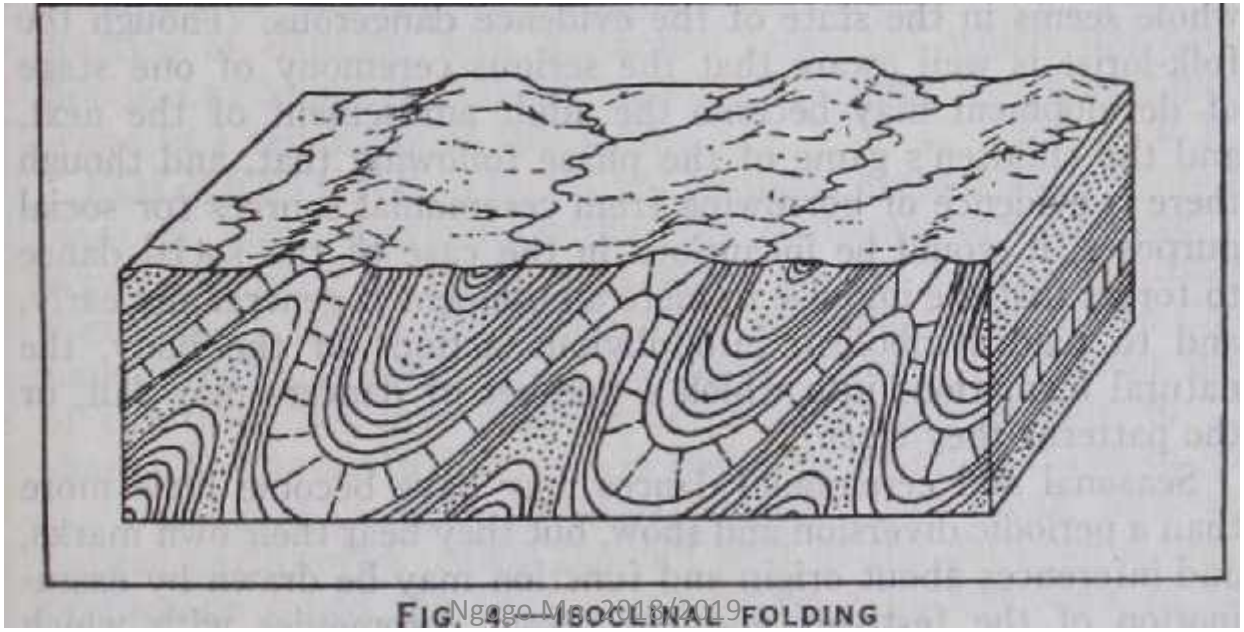
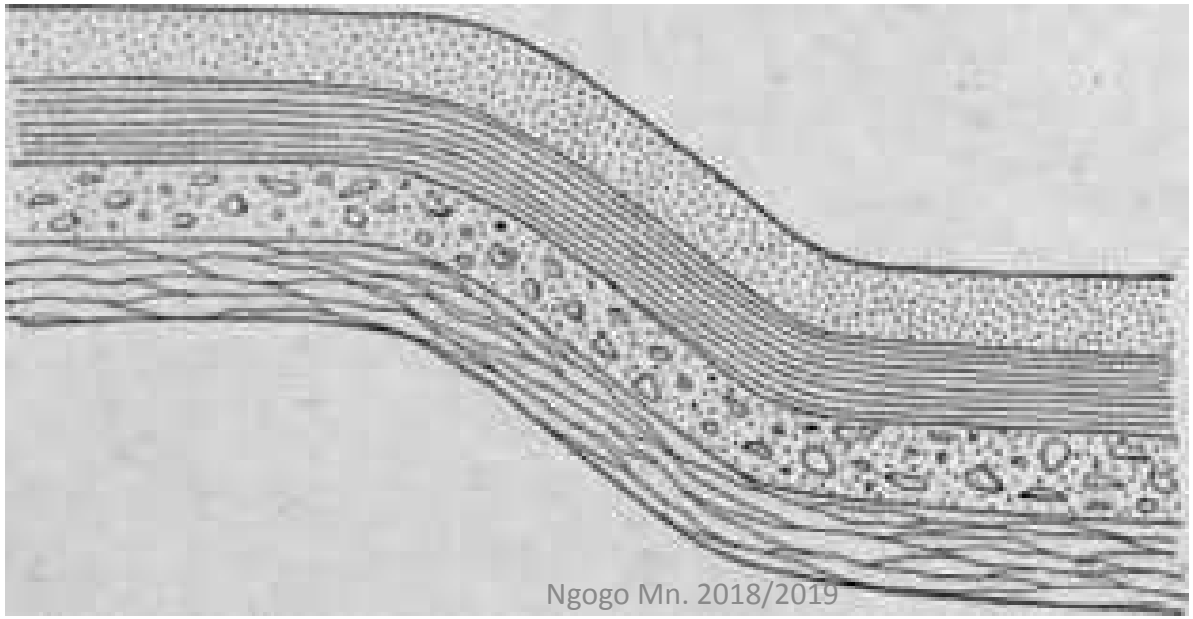


FIG. 4.—ISOCLINAL FOLDING

Isoclinal folds

4. Monoclinal Folds

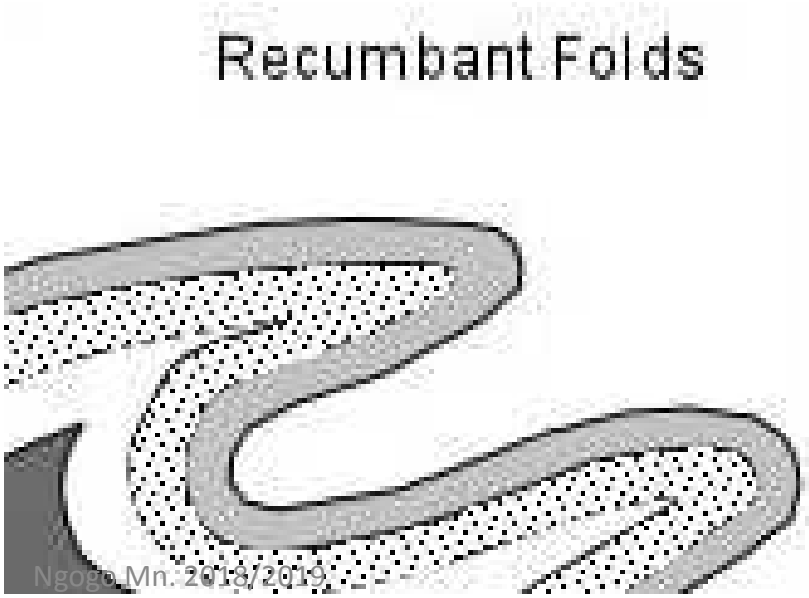
- It is a modified form of a symmetrical fold.
- One limb of the fold dips at right angle while the other at acute angle.
- Also formed by imposition of unequal compression on the limbs of the folds



Monoclined Fold

5. Recumbent or Overfold

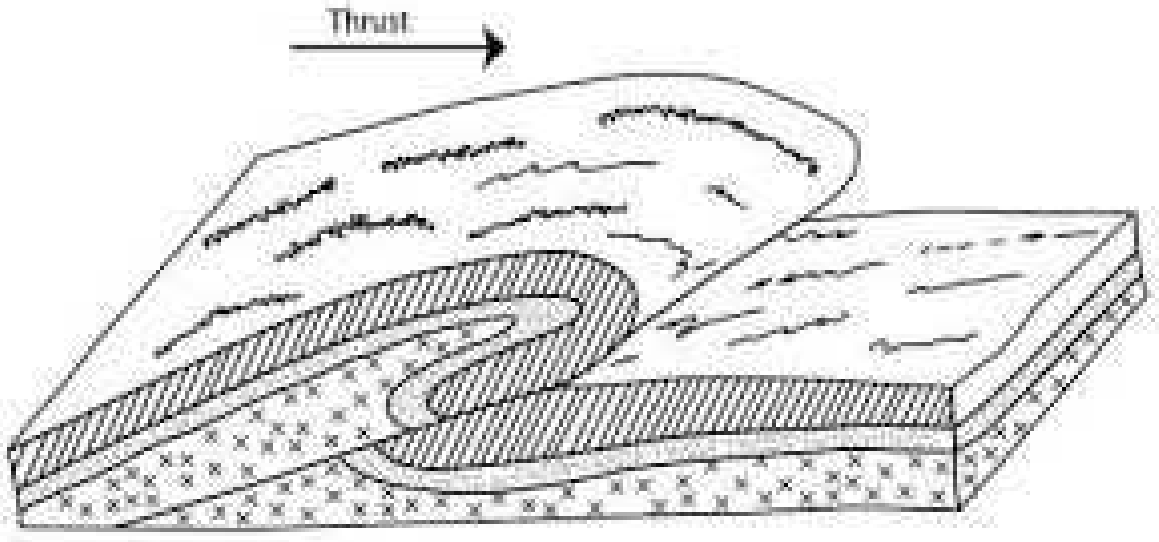
- Sometime, two limbs of the folds become parallel, one lies above the other, due to excessive amount of compression exerted on them from opposite sides.
- Limbs overturned and become horizontal in their axial plan.



Recumbent fold

6. Overthrust or Nappe folds

- When the compression force exceeds the bearing capacity of the rocks, the folds become very acute and break up.
- One limb thrust over the other, thus a thrust fault develops in a recumbent fold



Folding and Landforms

- 1. Fold Mountains
- Folding is responsible for wrinkling of the crust into lofty upfolds and deep down folds.
- The loft landscapes becomes a fold mountains such as Atlas, Himalayas, Rockie

A view of Himalayan Mountains in the North Eastern India

- 2. Valleys

- The wrinkled down folds may be in form of narrow and deep valleys. Such valleys are termed as synclinical valleys.

Synclinical valley at Usambara mountain ranges

3. Basins

- Sometimes the down folds associated to folding are broad and shallow as well as gently sloping.
- Such down folds are called synclinal basins
- For example: London basin, Paris basin, upper basin etc

Sudden Earth Movements

- There are two kinds of sudden earth movements

1. Volcanism
2. Earthquake

Volcanism or Volcanoes

- Volcanism is a process in which the hot rocks either in the form of liquid like magma or in the form of solid small pieces are ejecting out on the earth surface through a vent or passage of the crust
- Beside, streams gases and smokes are also coming out at the time of volcanic eruption

- Thus, the ejecting out of these materials from beneath the earth surface through the Vent is known as Volcano

Classification of Volcanoes

1. On the basis of nature of eruption
2. On the basis of ejected materials into different forms

On the Basis of Nature of Eruption

- There of two kinds

1. Central Type Volcanoes: when the volcanic eruption takes place through a vent with a great force and the ejected materials are deposited around the vent to form volcanic cones .Such volcanoes are known as centrally typed volcanoes

2. Fissure Type Volcanic Eruption.

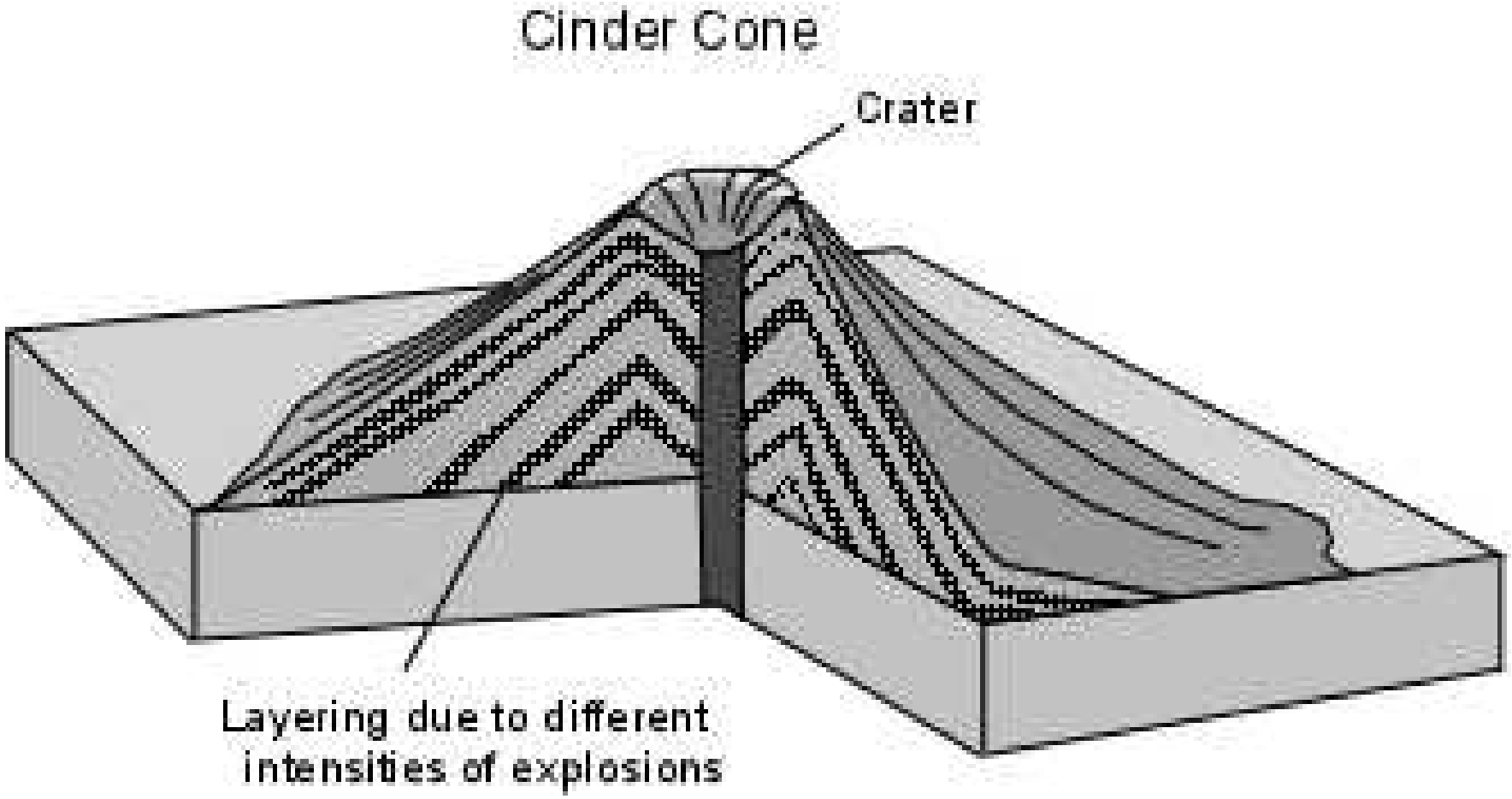
- When the magma or hot materials from within the crust are coming out on the surface through the fractures or cracks in the crust
- The flow of ejection is slow and ejected materials spread over the wide area like a thin sheet called as Volcanic Shields
- Deccan plateau of India formed by deposition of Magma through fissure eruption

On the Basis of Ejected Materials

1. Pyroclastic or Cinder volcanoes
2. Dome shaped volcanoes
3. Shield type volcanoes
4. Composite Volcanoes

1. Pyroclastic or Cinder volcanoes

- The volcanic cones which are formed by depositions of solid ejected materials like cinder lappili and ash through the vent of volcanoes, from beneath the earth surface.
- Such canoes are having rather more heights and steep slopes

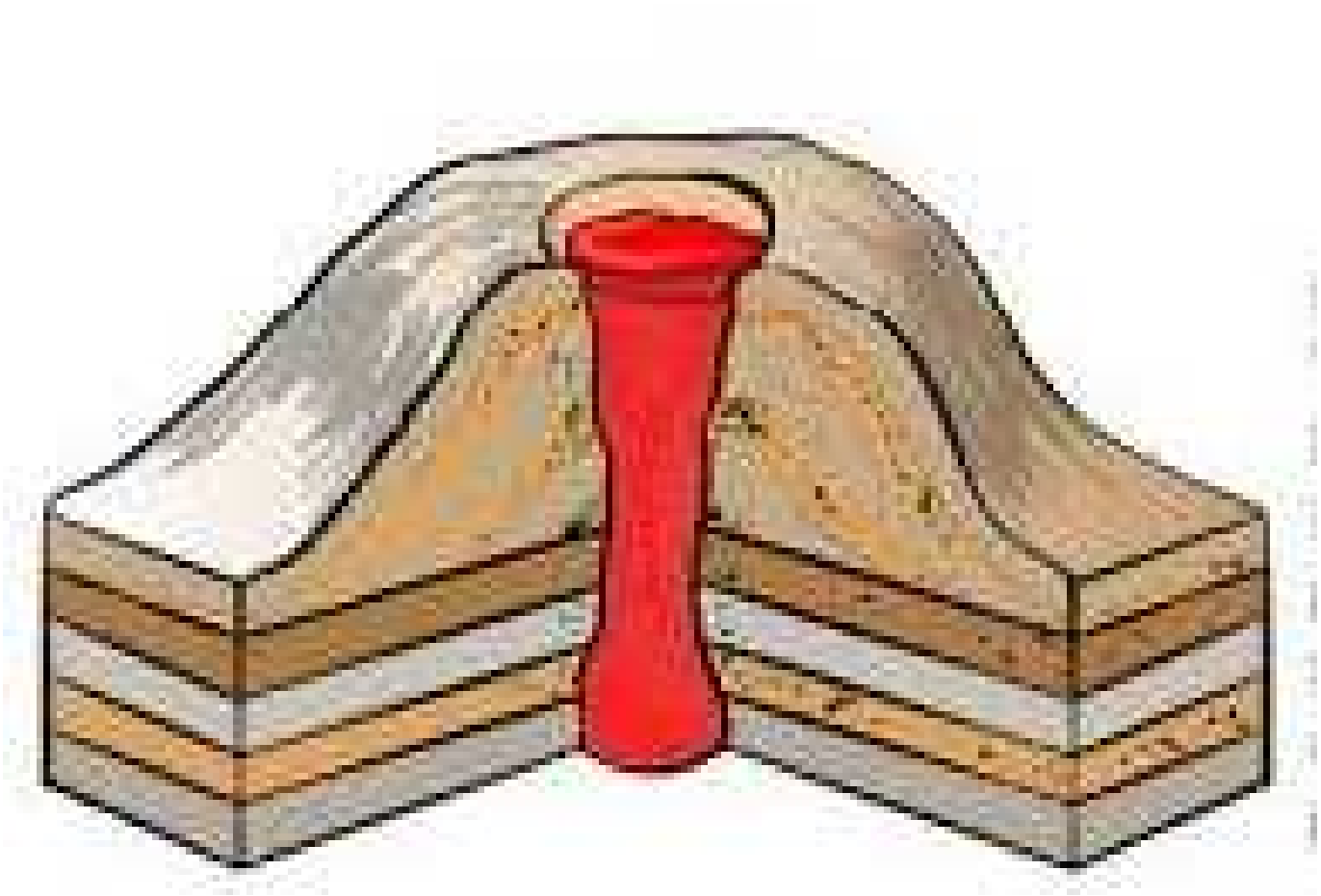

Cinder Cone
Crater
Layering due to different
intensities of explosions

Stromboli Mountain in Aeolian Islands

Dome Shaped Volcanoes

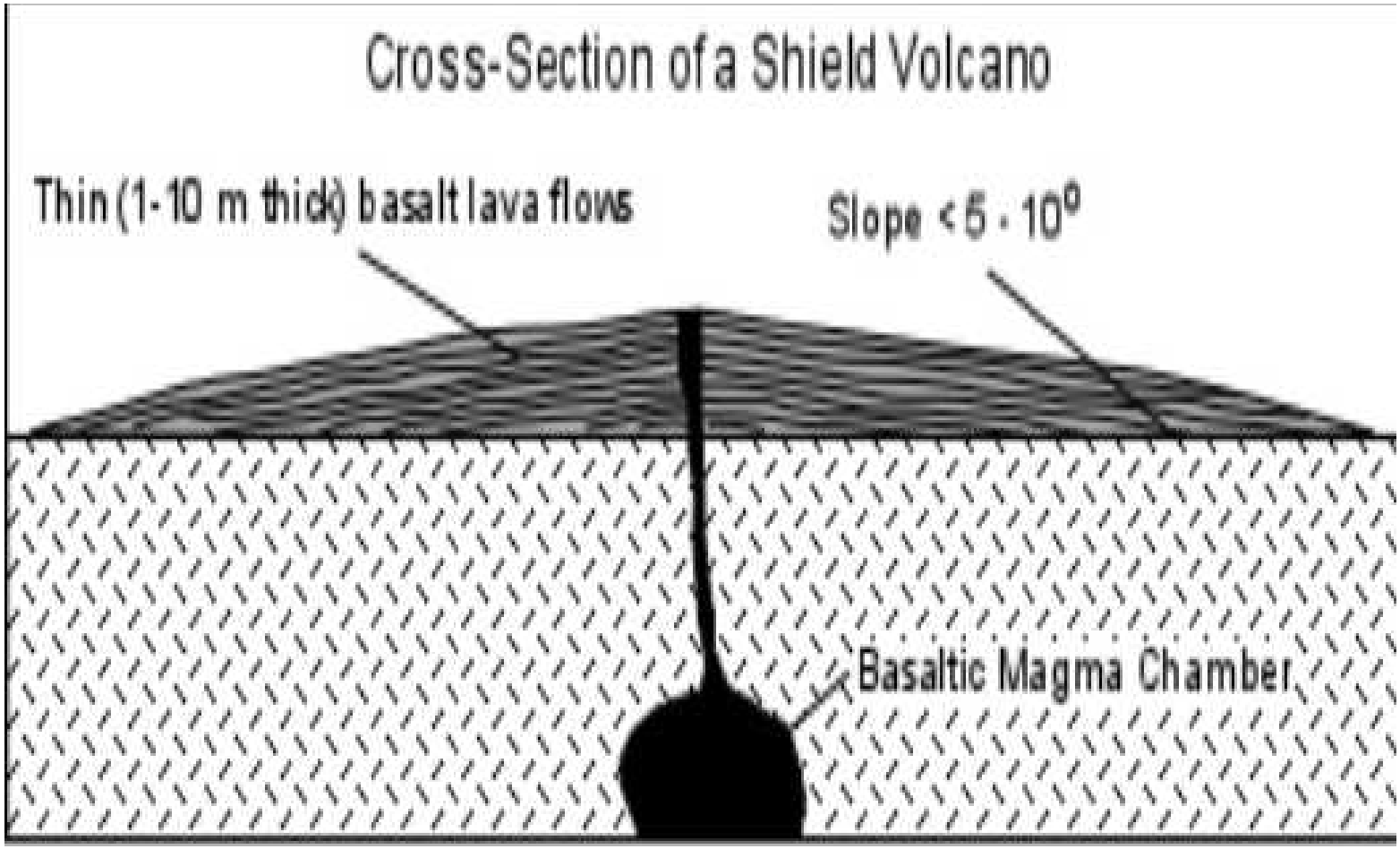
- When very viscous magma comes out and piles up in small area around the mouth of vent.
- It has narrow base and rather more height with steep slope (Also known as acid lava volcano)

Dome Shaped Volcanoes



Shield or Basalt Type Volcanoes

- The fluid basis magma spreads over a large area after the explosion through the volcanic vent due to its low viscosity.
- High rate fluidity the ejected and accumulated magma does not pile up to the considerable height.
- Base is broader and the height is rather low.
- Are also know as shield or basaltic volcano
- Usually plateau and those formed in oceans are of the same type, rarely rise above sea level

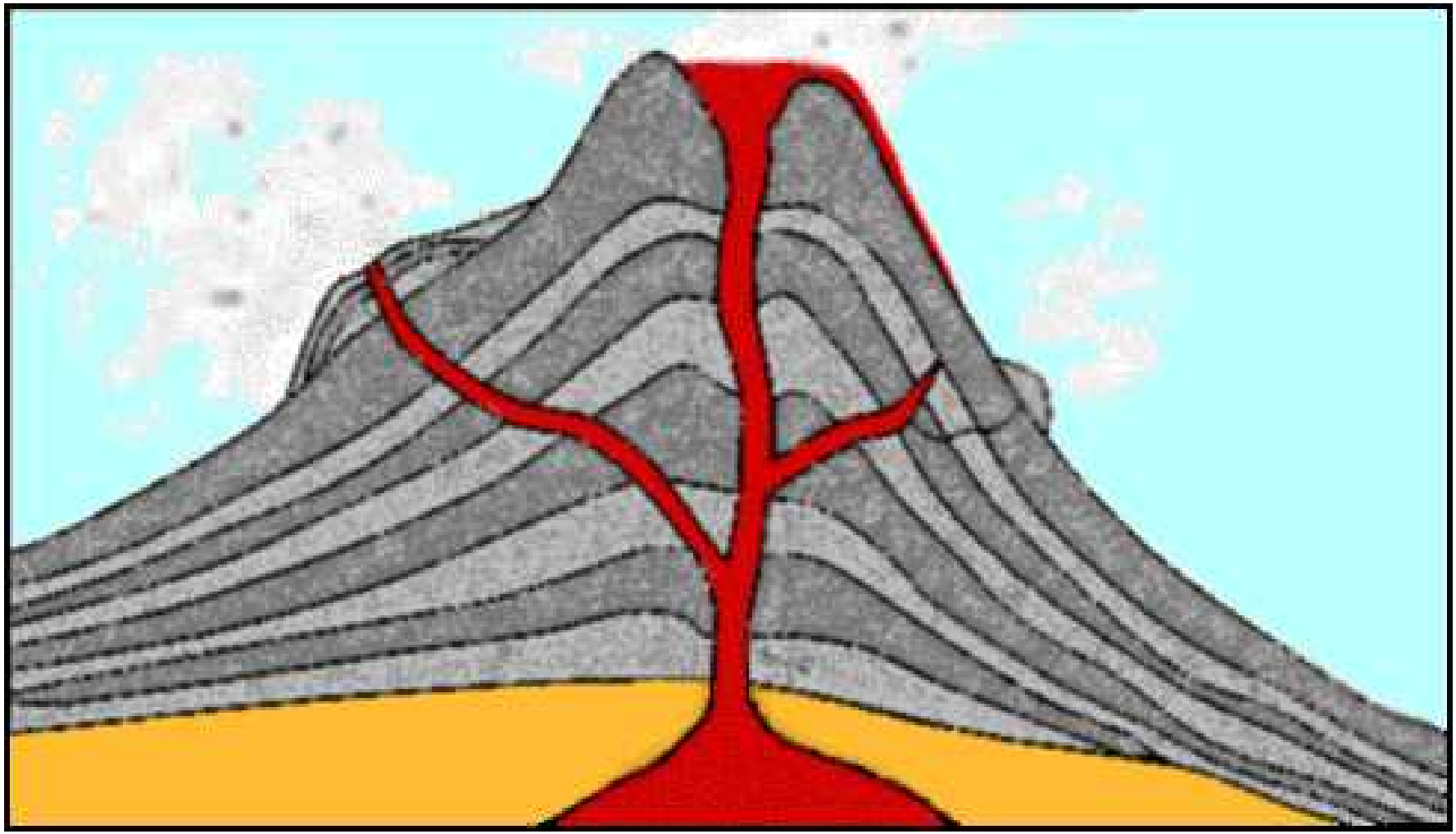

Cross-Section of a Shield Volcano
Thin (1-10 m thick) basalt lava flows
Slope < 5 - 10°
Basaltic Magma Chamber

Composite Volcanoes

- When a volcanic cone is formed by alternate accumulation of Pyroclastic (solid) materials and magmas ejected out around centre of the vent.
- It is formed of roughly alternating layers of lava and ash.
- Magma may penetrate the structure of volcanoes forming dykes radiating from the central vent.

- Rare volcanic eruptions with an individual material in isolation occur in the world but they are the combination of different types of ejected materials
- Fujiyama (Japan) and Vesuvius (Italy) are the examples of such volcanoes

Composite Volcanoes



Fuji Mountain (Japan)

On the Basis of Duration of Activity of Volcanic Eruption

1. Active Volcanoes: the volcanoes which show continous eruption. There are about 500 active volcanoes all over the world.
2. Dormant Volcanoes: The eruption activities of some volcanoes are ceased up due to some reasons for a long period.

- 3. Extinct Volcanoes
- Extinct volcanoes are such ones which have stopped for ever. Possibility of reoccurrence is not found there

Materials Ejected from the Volcanoes

1. Pyroclastic Materials: Include all types of solid fragmented materials ejected during volcanic eruption: Bomb, Cinder, Lappili, Ash and volcanic dusts are common PM according to the size of diameters of particles in descending order


Pyroclastic Material
volcanic ash/dust
volcanic bombs
lapilli

2. Lava and Magma:

- these are the main constituent of volcanic eruption.
- When the magma reaches on the earth surface is called lava

- Two kinds of magma

i. Acid

ii. Basic

i. **Acid Magma**

- Depending upon the content of silica. The acid magma is more viscous with high percentage of silica

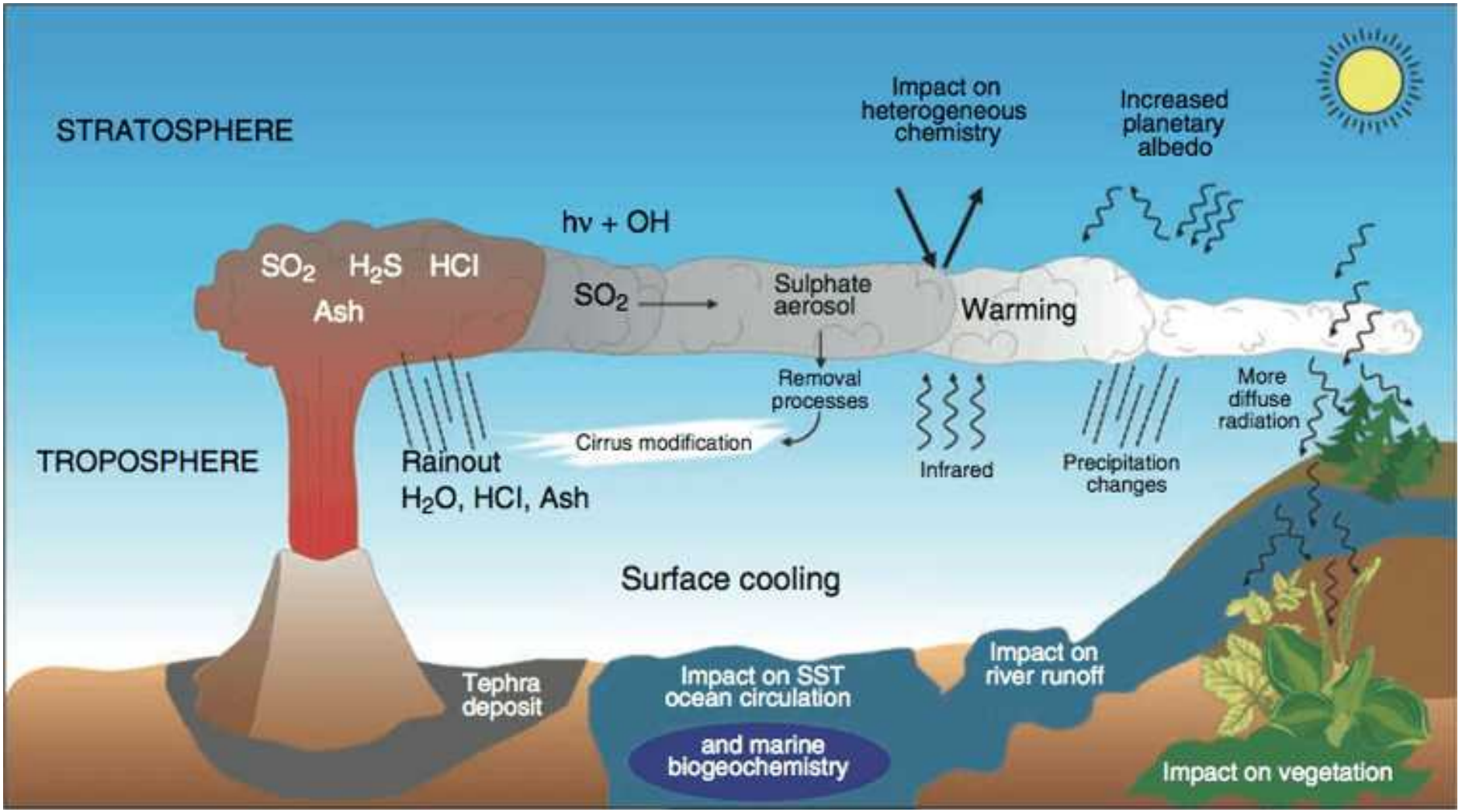
ii. Basic Magma

- It is non-viscous with low proportion of silica

3. Vapours and Gases

- Steams and gases of different types are ejecting out at the time of volcanic eruption.
- Carbon dioxide, hydrogen, Sulphur dioxide, carbon mono-oxide etc are important volcanic gases

Vapours and Gases (from volcanoes)



CAUSES OF VOLCANISM

- Formation of volcanoes takes place due to the ejection of hot solid, liquid and gaseous materials from beneath the earth surface.
- The most important matter, which is to be explored is the cause of formation of magma and its ejection after the breaking of overlying rocks..

1. Percolation of Water

- Water percolates down from the bottom of water bodies like sea and oceans in large proportions to underground
- Temperature in the interior of the earth is high as it increases at a rate of $1^{o}C$ for 165 Mt depth from the earth surface
- When the percolated water gets contact with hot rocks, converts into steams and vapours.

- The steams and vapours make Endeavour to come out and along the weak zone of the earth crust, wherever outlets are available.
- Due to great force of these steams, some molten materials like magma begin to eject and form volcanoes on the earth surface
- More than 90% volcanoes are found along the continents and ocean's margins

2. Tectonic Earth Movements

- T the time of mountain building movement, the crustal rocks are deformed into form of folding and faulting.
- Faulting leads to dislocation and displacement of rocks along the fault planes causing the release of super incumbent pressure of overlying rocks inside the earth crust.

- Beneath the earth surface relatively at 100 km depth temperature is very high due to disintegration of radioactive elements.
- Under high temperature rocks are not melted due to increasing pressure of overlying rocks.
- The pressure increases the melting points of the underlying rocks.
- Tus, when pressure of overlying rocks is released by by dislocation of the rocks in tectonic movement, the underlying rocks are melted and magma is formed in the upper mantle

- This magma ejects out through the weak zone of the earth crust to form the volcanoes.