UNIT ONE

Major Geological Processes Associated with Plate Tectonics

1.1. The Continental Drift Theory

- It is a 20thC Geo-Physics theory produced by a German meteorologist Alfred Wegener, in 1912.
- According to Wegener all the present day continents were once part of a single super continent called PANGAEA from which the continents we see today have broken out and moved apart to their current position through millions of years.

- **During the Carboniferous period, some 350 million years ago, Pangaea was located around the South Pole.**
- **In the Triassic period of Mesozoic era, Pangaea started to break into several parts. He called them Laurasia and Gondwanaland.**
- **The northern part of Pangaea is known as LAURASIA. The northern part of Pangaea making N. America, Greenland, Europe and Asia.**
- **The southern part of Pangaea is known as GONDWANALAND, which consists of S. America, Africa, Australia, Antarctica and the sub continent of India and Arabia.**

Geological Evidences Favoring Continental Drift Theory

- **The major geological evidences suggested by Wegener to prove his theory are:**

- **Coastline Similarity: The coastlines of Africa and South America have remarkable similarity in opposite side of the Atlantic Ocean. These coastlines fit together like pieces of a jigsaw puzzle.**



ıre 1.2: Fitting of Africa and South America together

- **Rock type and structural similarities: The discovery of similar layer of rock in Africa and south America. Moreover, several mountain belts also extend from one continent to the next.**
- **Fossil Evidence: cases of several fossil organisms had been found on either side of the Atlantic Ocean. Example, Mesosaurus was a small reptile that lived about 250 million years ago .**

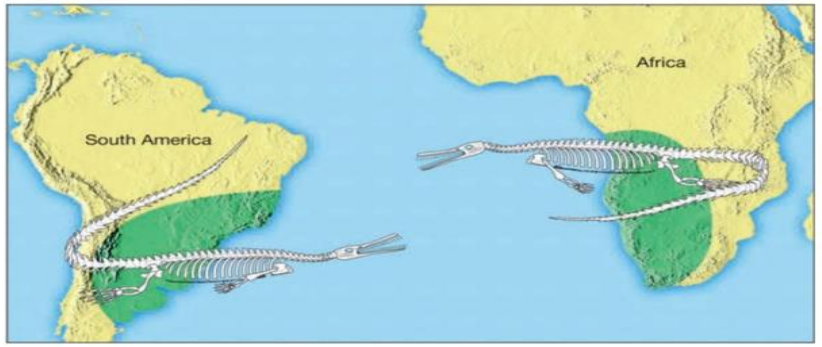


Figure 1.3: Distribution of Mesosousarus

- **Paleoclimatic Evidence: similarity of climatic data reconstructed from rock structure are similar in the present continents.**
- **Wegener's theory of continental drift was rejected by scientific community of the time. The main reasons for this rejection were:**
  - ✓ **Wegener was not a geologist by profession**
  - ✓ **Most of the conclusive data came from the Southern Hemisphere.**
  - ✓ **Wegener thought that Pangaea did not break up until Cenozoic era, and scientists found it hard to believe that so much continental drift could have occurred in so short a time.**

- ✓ **The greatest problem remained the lack of direct evidence for the movements of continents and the needed explanation for the mechanism.**

➢ **Regardless of the controversies mentioned above, perhaps Wegener's most important legacy is to have introduced the idea of lateral mobility of continents, that is, offering a paradigm change from fixism to mobilism to the scientific community and the public.**

1.2. Plate Tectonics Theory

➢ **The word tectonic came from Greek word "tectonikos" which means builders.**

- **Plate tectonics is a theory developed in the late 1960s to explain how the outer layers of the earth move and deform.**
- **The scientific background of the emergence of plate tectonic theory are:**
  - **the discovery of the seafloor expansion and**
  - **the emergence and acceptance of continental drift theory**
- **According to plate tectonic theory, the layer, called the asthenosphere, allows the uppermost mantle and crust, together called the lithosphere to slide across the top of it.**
- **According to the plate tectonic theory, earth's lithosphere(crust) is broken into about a dozen of large and small pieces, called plate.**

- **Plate may be entirely made up of continental rock and oceanic rock**
- **The major large plate includes:**
  - ✓ **The Pacific plate**
  - ✓ **The Antarctica plate**
  - ✓ **The Euro- Asian plate**
  - ✓ **The African plate**
  - ✓ **The Indo- Australian plate**
  - ✓ **The North American plate**
  - ✓ **The South American plate**
- **The smaller plate includes:**
  - ✓ **The Nazca plate**
  - ✓ **The Philippine plate**
  - ✓ **The Caribbean plate**
  - ✓ **The Cocos plate**

- **These plate moves slowly at a rate of a few centimeters per year and change size. The plate moves in different direction and meet each others at plate boundaries.**

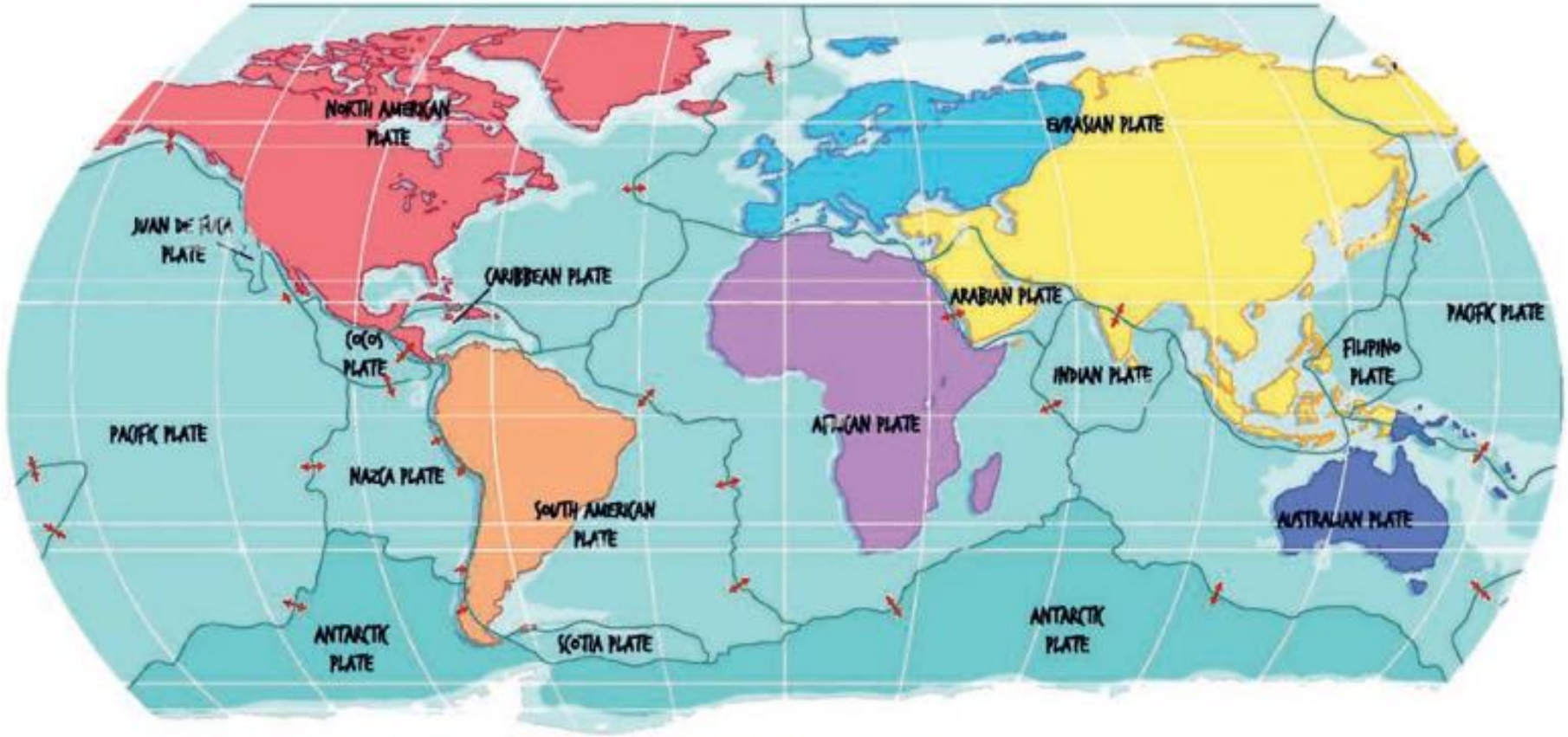


Figure 1.5: The Tectonic plates and their boundaries

1.3. Plate Movements and Plate Boundaries

- **Plate divided into two, namely continental and oceanic crust.**
- **Continental crust, made largely of less dense granite(sial), while oceanic crust made largely of hard dense basalt(sima). These plates are in constant motion due to the convective currents in the mantle.**
- **The movement of the plate creates three types of tectonic plate boundaries.**
  - **Convergent (Destructive) boundary**
  - **Divergent (Constructive) boundary or**
  - **Transform (Conservative) boundary**

Convergent plate boundaries

- **Convergent boundaries occur when two plates collide with each other. At such boundaries, the dense plate will be forced under or subducted beneath the less dense one. The subjected crust is eventually destroyed. Usually, one of the converging plates will move beneath the other, a process known as subduction.**

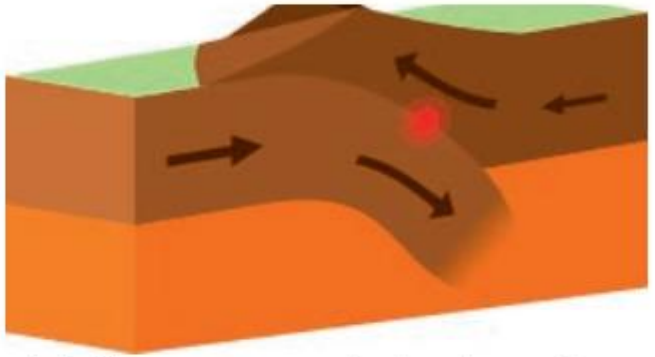
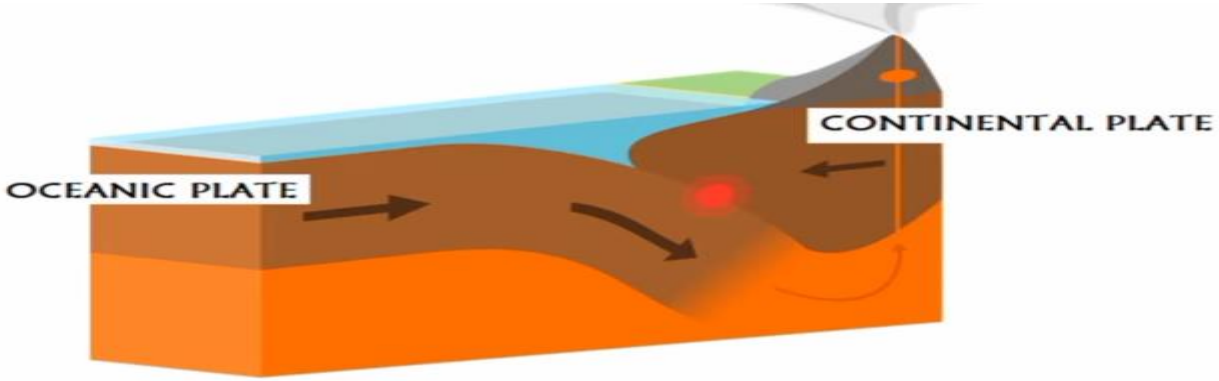


Figure 1.6: Convergence of plate boundary

- **Subduction:** a subduction is an area where one plate sinks underneath anther. This typically happens at **oceanic-continental boundaries** and **oceanic- oceanic boundaries**. Features associated with a subduction zone include: **volcanic arc, island arcs** and **trenches**.
- There are three types of convergent boundaries: **oceanic-continental, oceanic-oceanic,** and **continental-continental**.

Oceanic-continental Convergent

- When an **oceanic plate collides with a continental plate**, the denser oceanic plate subducts beneath the continental plate. **For example**, the **Andes mountain** formed as a result of the collision between the South American and Nazca plates.

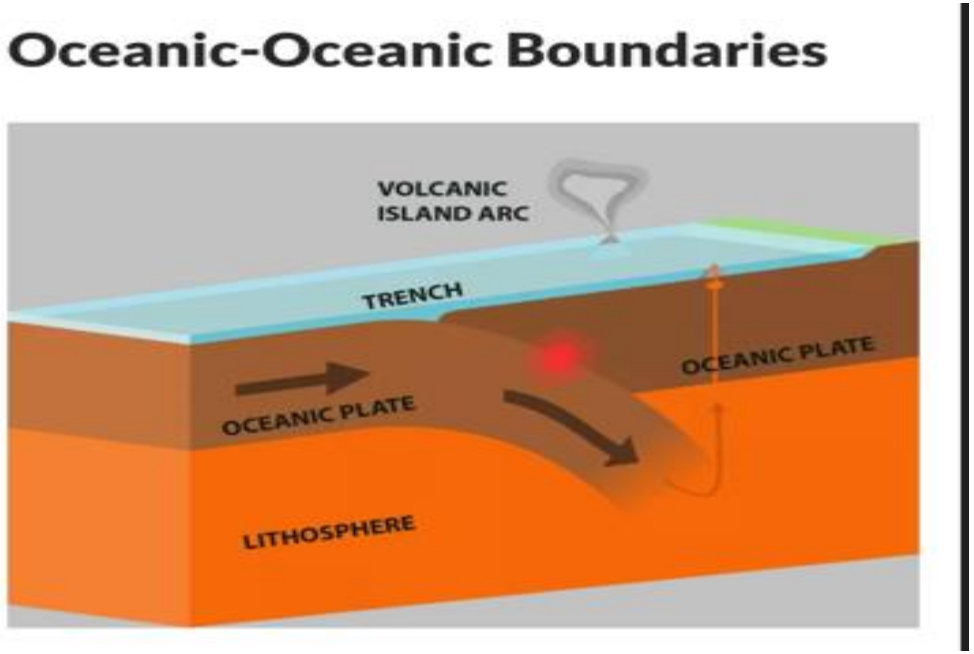


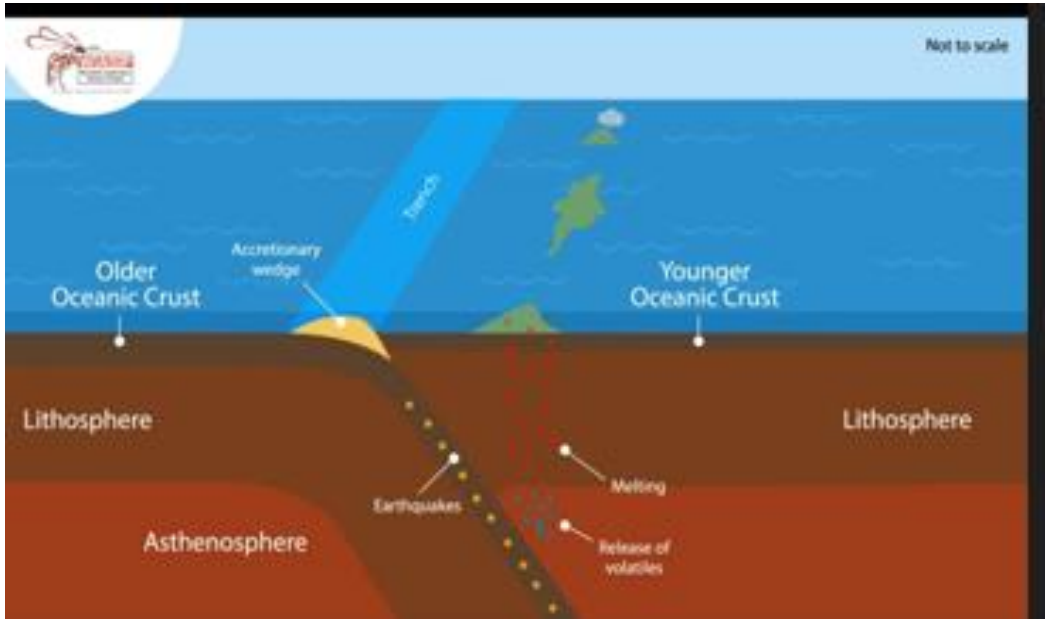
Subduction occurs when an oceanic plate runs into a continental plate and slides beneath it.

Oceanic-oceanic Convergent

- **When two oceanic plates collide, one subducts beneath the other, often resulting in the formation of volcanic island arcs. Example, The Mariana Islands of the western Pacific Ocean were formed this way.**

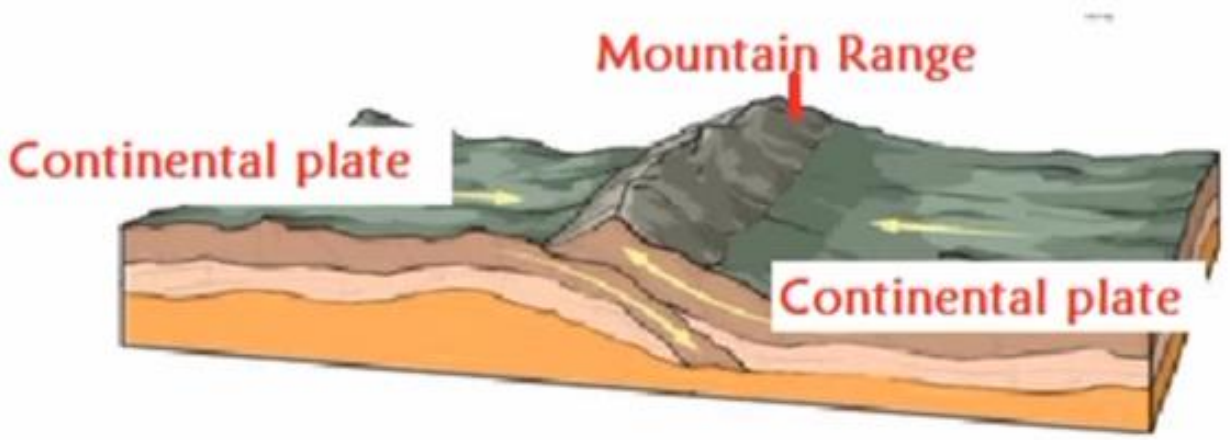
- **Trenches** are long, narrow depressions that form at convergent boundaries where two plates collide. Trenches are typically found in **oceanic-continental** and **oceanic-oceanic convergent boundaries** and are associated with deep-sea trenches and subduction zones.





Continental –Continental Convergent

- **At continental- continental crust convergence(collide), the crust crumples(crushes) and buckles or folded into mountain range. Example, Himalayas- the highest mountain range on earth, formed the collision of Indo-Australian plate with Eurasian plate.**



Divergent plate boundary

- **At a divergent boundary, the plates move away from each other. The effect varies depending on whether the divergence takes place under the oceanic plate or continental plate.**
- **when divergent boundaries occur in the oceanic plate, it results in the formation of mid oceanic ridge, such as in the middle of the Atlantic Ocean as well as new seafloor spreading .**
- **Mid-Ocean Ridges: These underwater mountain ranges form at divergent boundaries where plates move away from each other, allowing magma to rise to the surface and create new crust.**

- **Divergent boundaries can occur on land(continents), forming rift valley. Example, the East African rift valley.**

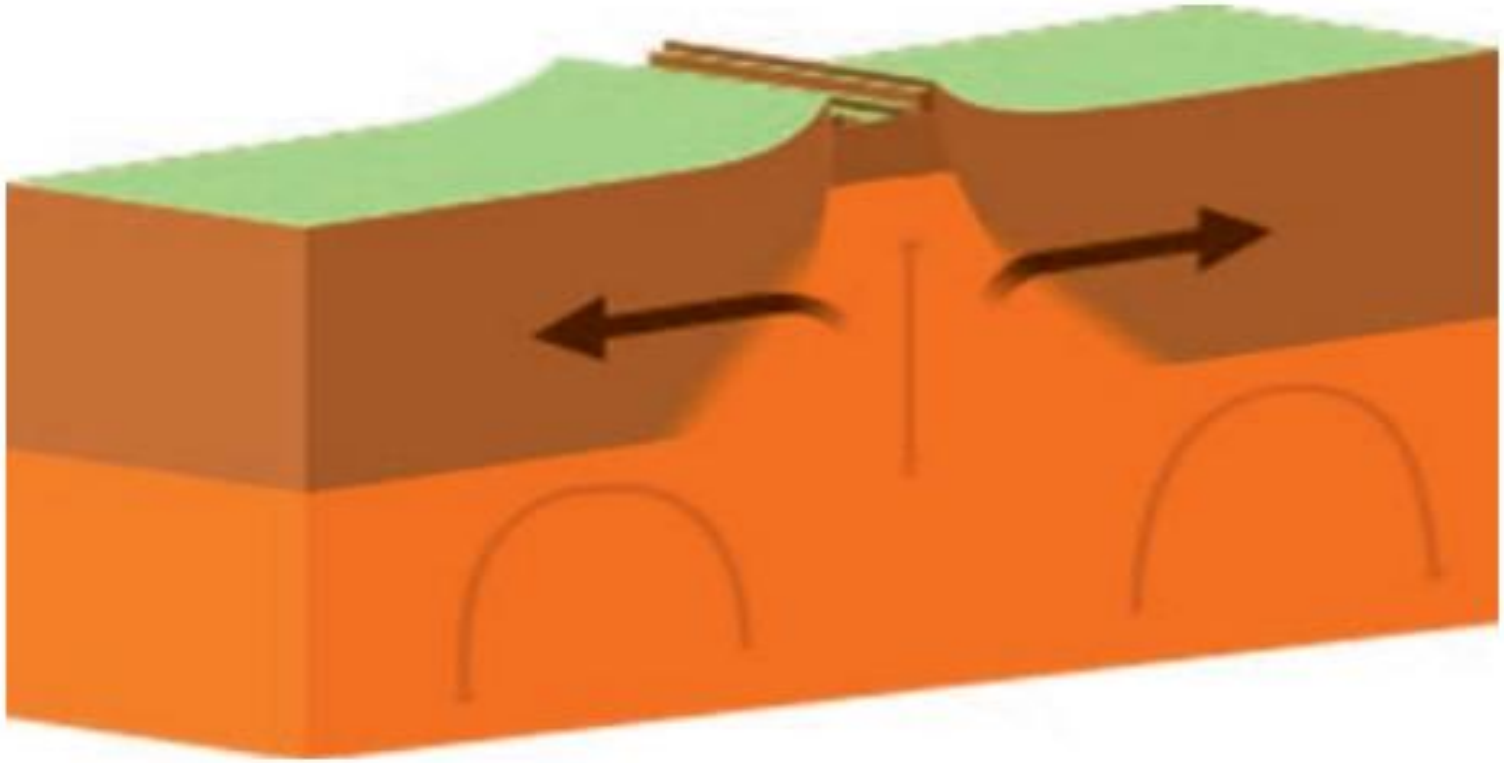


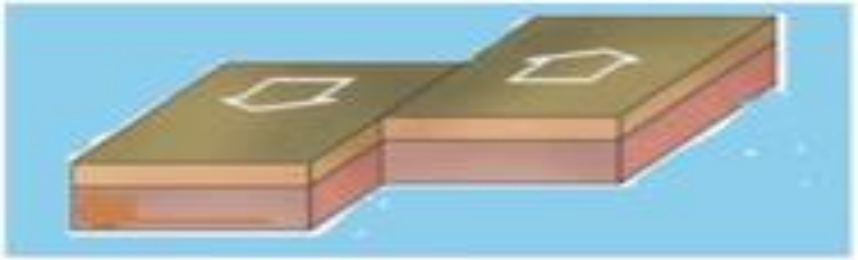
Figure 1.7: Diverging Plates

- **Divergent boundaries are constructive boundaries because new crust is generated by magma pushing up from the mantle as the plate moving away from each other.**

Transform Fault boundaries

- **Transform boundaries are occur where two plates slide past each other horizontally.**
- **Transform boundaries often results in intense seismic activity, causing frequent earthquakes.**
- **if two plates slide each other, faults can occur on the continents, such as the San Andreas Fault in California(the largest fault in the world).**
- **A transform faults is conservative boundaries , because crust is neither destroyed nor created.**

In the transform plate boundary, the plates slide past one another without the production or destruction of crust.



Why do the plate move?

- **Plate tectonics is driven by the internal energy of the Earth. Most geoscientists agree that motion of convection currents that circulate in the mantle causes plate movement.**

1.4. Major Geological Processes

- **The Earth is a dynamic planet. Geological processes occur constantly, some of them going on invisible for us; while others causing a great damage.**
- **The term "geological processes" describes the natural forces that shape the physical makeup of our planet earth. The forces that bring about changes on the earth's surface are divided into two. They are:**

1. Endogenic forces

2. Exogenic forces

1.4.1. Internal (Endogenic) Forces

- **Internal forces are forces that come from the inside of the earth. These forces create irregularities or unevenness on the face of the earth. They form ups and downs on the crust of the earth by breaking, bending, or folding the rock.**

1. FOLDING

- **Folding occurs when rock layers are pushed by earth movements sideways. The movement may be only from one direction. It may also be from two directions. When rock layers are pushed from two directions, they are compressed. Then, the rock layers are folded**

- **The layers of rock bend up from an upfold or anticline. Those which bend down form a downward arch or syncline.**

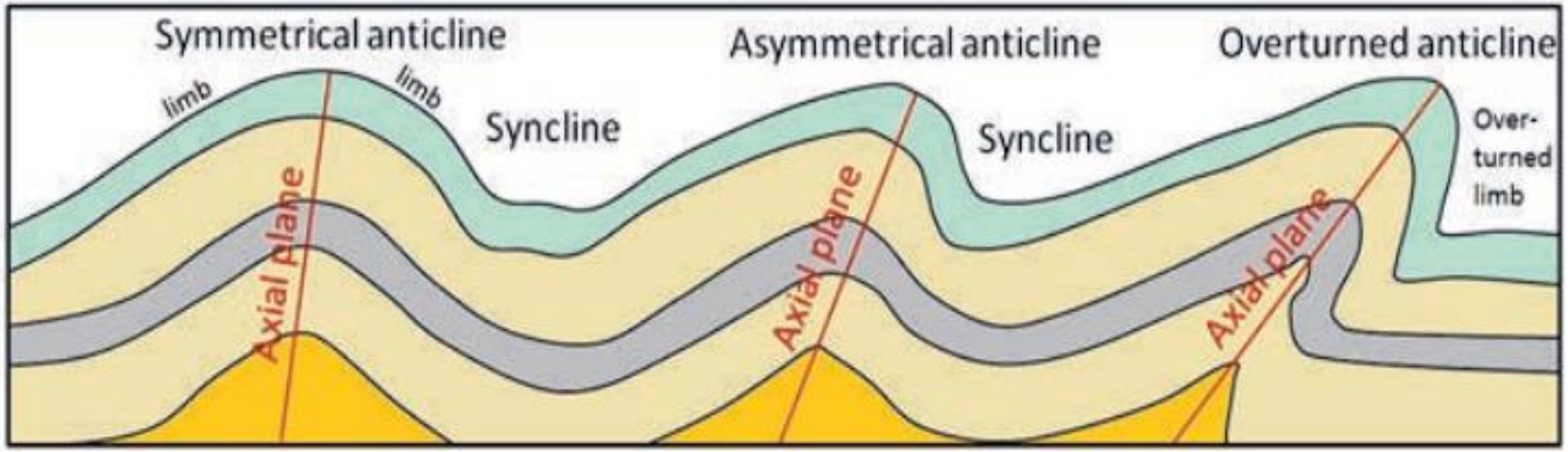


Figure 1.10: Anticline, syncline

If compression continues then simple folds are changed into asymmetrical folds, over folds and over thrust folds. (Figure 1.10)

Formation of fold Mountain

- **Fold mountains are formed through a process called orogeny, which occurs when two tectonic plate collide(converge).**
- **During the last 400 million years, there have been shown three mountain building periods:**
  - **Caledonian Orogenesis(observed 320 million years ago)**
  - **Hercynian Orogenesis(observed 240 million years ago)**
  - **Alpine Orogenesis(observed 50 million years ago)**

Types of Fold Mountains

- **The Fold Mountains of the world are grouped into two: They are:**

  1. Old fold mountains

  2. Young fold mountains

Old fold mountains

- **formed during the first and the second mountain building period.**
- **Example, Scandivian mnts., Appalachian mnts.(in USA), Ural mnts.(in Russia) and Cape range(Drakensberg) mnts(in RSA)**

Young fold mountains

- **Formed during the third mountain building period(Alpine orogenesis).**
- **Mountain belongs to this group include Himalayas(South Asia), Andes(South America), Alps(Europe), Atlas(North Africa), Rockies(North America) and Australian Alps(Australia).**

❖ **Himalayas: were formed from the ongoing collision between the Indian and Eurasian tectonic plate. The Himalayas include several of the world's highest peak, including Mt. Everest.**

❖ **The Andes: located along the western edges of South America.**

✓ **The Andes is formed as a result of the collision between the South American and Nazca plate.**

✓ **They are the longest continental mountain range in the world.**

❖ **The Alps: the Alps mountain range located in Europe. They are formed as a result of the collision between the African and Eurasian plates.**

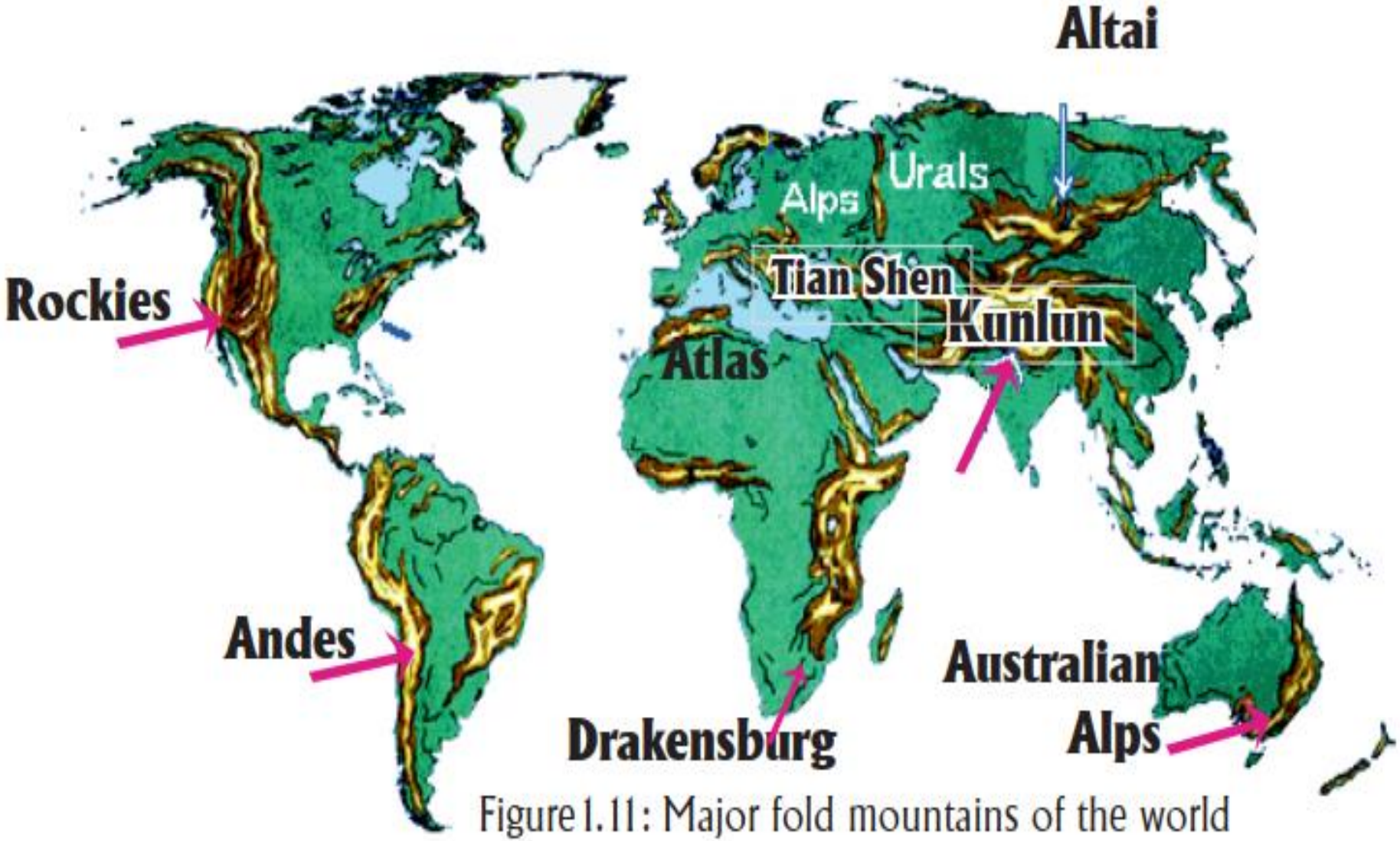


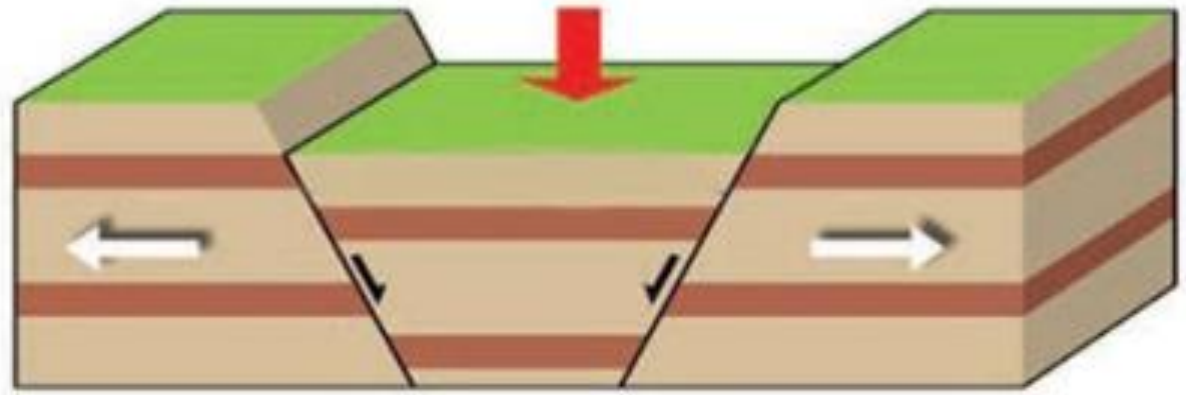
Figure 1.11: Major fold mountains of the world

2. FAULTING

- **A fault is a crack on the earth's crust. It is formed by the forces of tension and compression. A fault may occur in the rocks along a single line. When this happens, rocks are displaced either upward or downward.**
- **Tension force causes normal fault. Tension commonly occur in the divegent plate boundaries.**
- **Compression force causes a reverse fault. Compression commonly occur in the convergence plate boundaries.**
- **faulted resulted the development of various landforms. Some of the major landforms created by faulting are:**

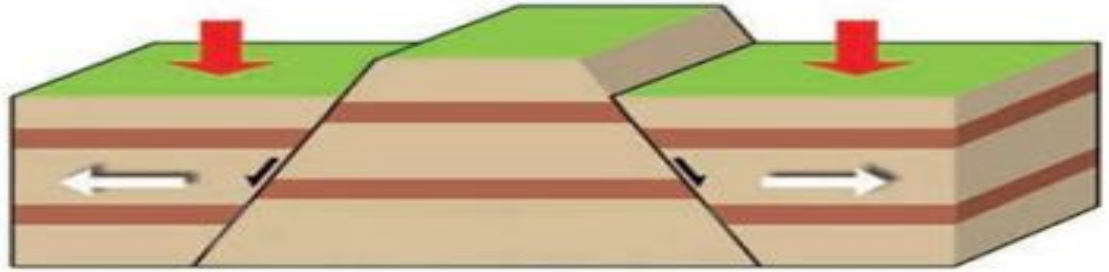
1. **Rift valley(Grabens)**
2. **Horst(Block) mountains**

- **Rift valleys: are formed when the land between two faults sinks down. The blocks on both sides of the valley form plateaus. For example, the East African Rift Vally.**



Graben/ Rift Valley

- **Block(Horst)Mountains: are formed when the land between two parallel faults is pushed upward. For example:. the Afar Horst mountain.**



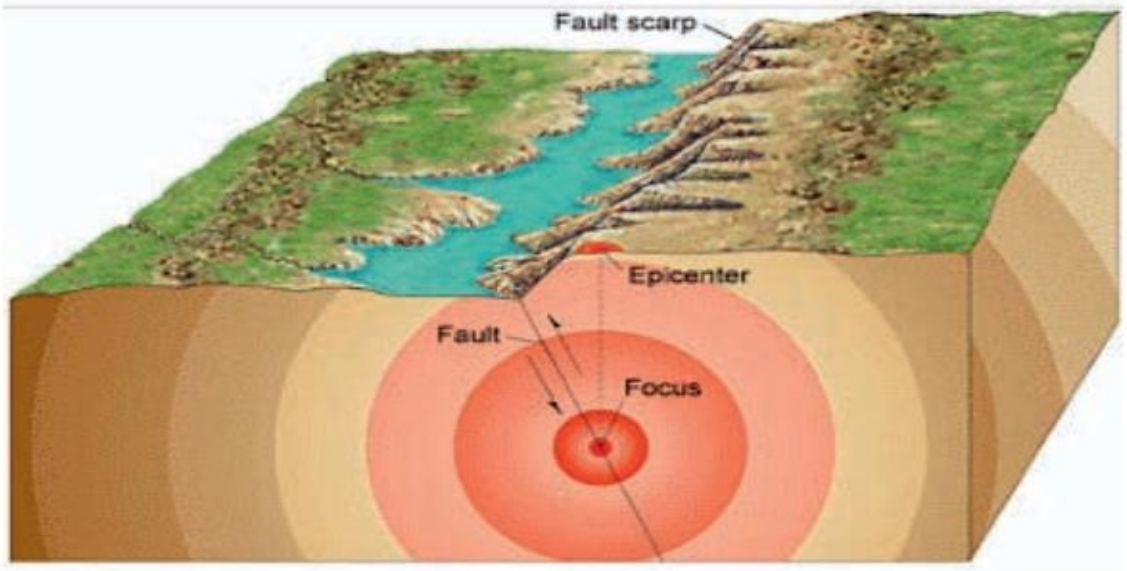
Horst/ Block Mountain

3. Earthquake

- **An earthquake is a sudden movement and violent shaking of the ground in the crust of the earth. These movements are caused by the movement of tectonic plate beneath the earth's surface/ rapid release of strain energy that is stored within the rocks of the crust..**

- **The shifting of the rock releases a great amount of energy, sending out shock waves that travel through the rock, and cause the ground to shake. These shock waves, called seismic waves.**
- **Earthquakes occur most often along geologic faults, which are fractures in the rocks of Earth's crust. Along faults, the rock masses on opposite sides of the fracture strain against each other and sometimes "slip," causing an earthquake.**
- **The major fault lines of the world are located at the fringes(border) of the huge tectonic plates that make up the crust.**

- **The strength of an earthquake is measured by an instrument called seismograph and the unit of measurement is Richter scale.**
- **The Richter scale gives reading from 0 (no movement) to 9 (extremely severe).**
- **The point at which an earthquake originate in the crust is called focus. While the point directly above the focus on the surface is called epicenter.**



1.14 Focus and Epicenter of an Earthquake

Types of seismic waves

- **In the context of earthquake, there are two main categories of seismic waves.**

1. Body waves and

2. Surface waves

- **Body waves: are seismic waves that travel through the interior of the earth. They are two types of body waves, namely**

    1. P or Primary waves and

    2. S or Secondary waves.

- **P waves spread in the crust from the point of rupture, which is called the focus of the earthquake.**
- **P waves are characterized by the ability to compress and expand the rock through which they pass and vibrate in the same direction in which the wave travel.**

- **Secondary waves: causes rock vibrate at right angles to the direction of the wave travel. These secondary waves are the location of an earthquake many thousands of miles away.**
- **Surface waves: are seismic waves that travel along the earth's surface. There are two types of surface waves: love waves and Rayleigh waves.**
- **Surface waves are travel more slowly than body waves, but the surface waves causes the most significant ground shaking and are responsible for much of damage and destruction associated with earthquake that occur far from the epicenter.**

Effects of Earthquake

- **Earthquakes often cause dramatic changes at the Earth's surface, such as**
  - **Changes in the flow of groundwater, landslides, and mudflows.**
  - **Significant damage to buildings, bridges, pipelines, railways,**
  - **Earthquakes can lead to devastating fires.**
  - **Underwater earthquakes can cause giant waves called tsunamis.**
  - **The rise and lowering of the sea floor, etc.**

Areas of the world frequently affected by earthquake

- **A belt in the pacific ocean: the largest earthquake and volcanic zone lies along the edges of the pacific ocean. This zone known as pacific ring of fire or circum pacific belt.**
- **A belt between Europe and North Africa through the mediterranean region. It then run eastward through Asia.**
- **A long the mid oceanic ridges and the Great rift valley of east Africa.**

❖ **The deeper focus earthquakes commonly occur in Benioff zones, which dip down into the mantle at places where two tectonic plates converge.**

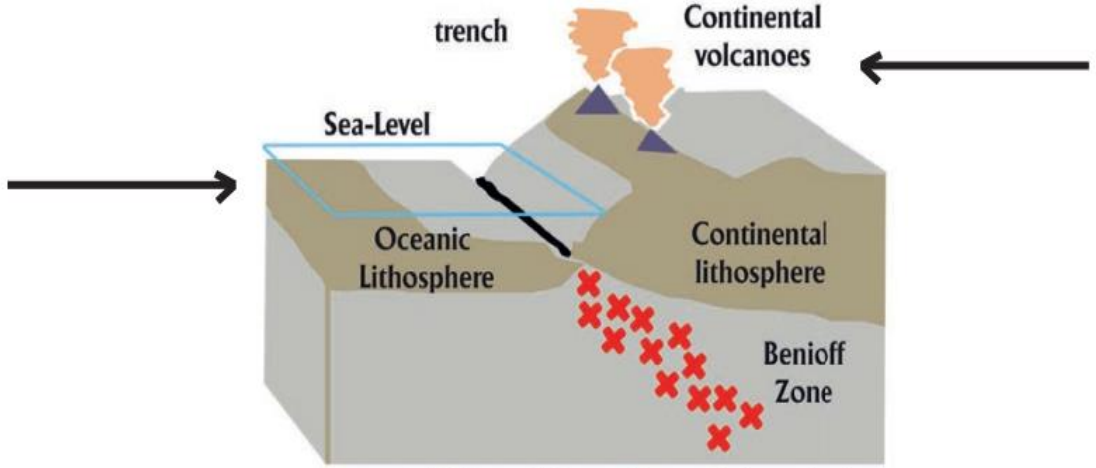


Figure 1.17 Benioff Zone along subducted plate

4. Volcanism

- **Volcanism is the process by which molten rock or magma, together with gaseous and solid materials is forced out on the surface of the earth.**

- **when magma reaches into the earth's crust it is known as lava. Magma reaches into the earth's crust through two types of openings. They are:**

  1. Vents and

  2. Fissures

- **Vent: is a small hole or opening like a pipe. If lava flow through a vent it build up a volcano(a cone shaped mound).**
- **Fissures: are large and narrow crack in a rock. If lava emerges via a fissure it build up a plateau.**

Occurrence of volcanic Activity

- **Volcanoes occur mainly near the boundaries of tectonic plates. They form along belts of tension, where plates diverge, and along belts of compression, where plates converge.**
- **The major areas of volcanic activity include:**
  - **The Pacific Ring of Fire (Almost 90% of volcanic eruption)**
  - **The Mediterranean – Asian belt**
  - **Along the world's oceanic ridge and**
  - **The Great Rift valley of East Africa**

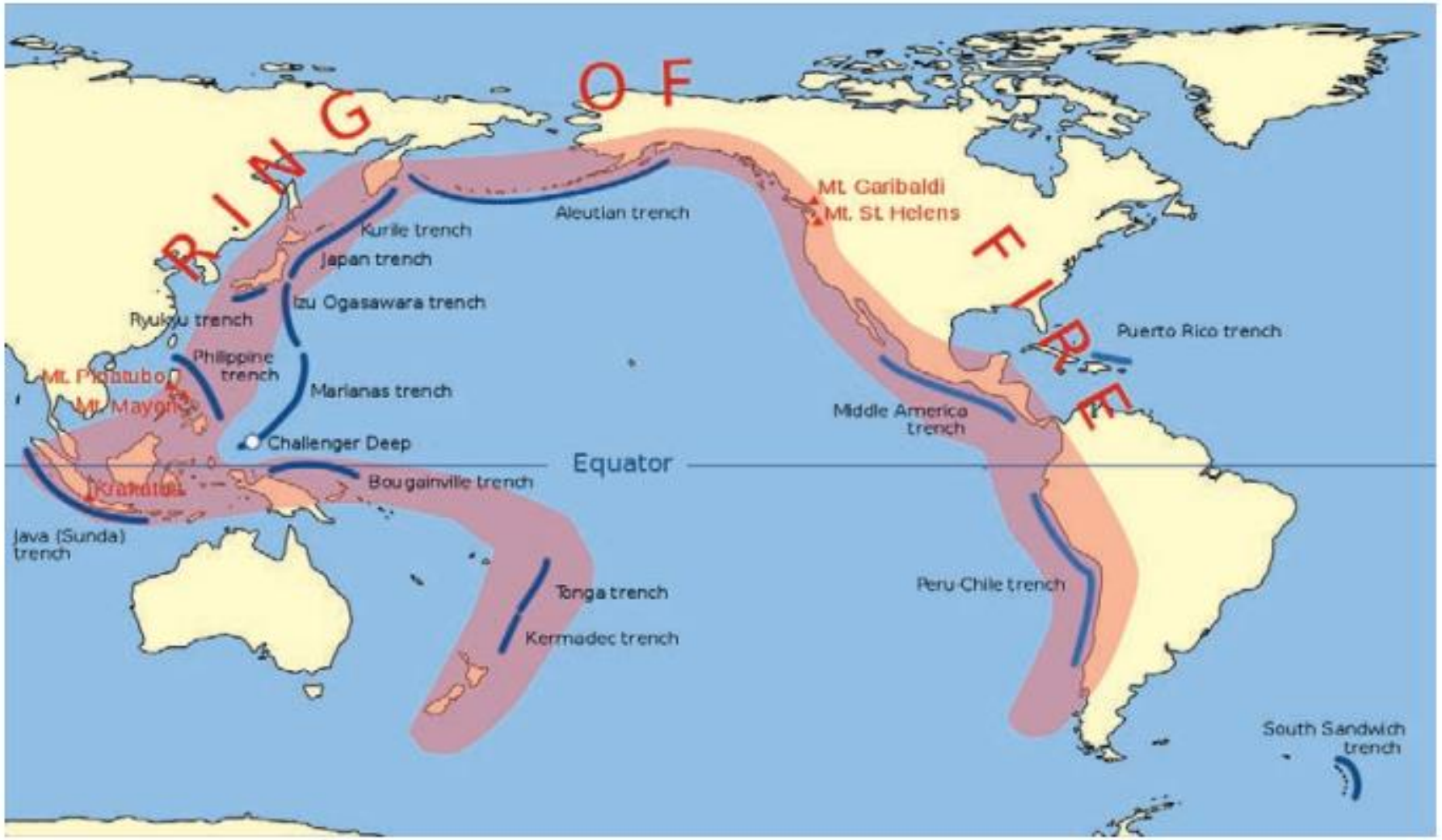


Figure 1.18: Pacific Ring of Fire

Types of Volcanoes

- **Based on their eruption or activity level, volcanoes can be classified into three:**
- **Active volcanoes: are volcanoes currently erupted within the last 500 years(volcanoes known to have erupted during historic time). Example, Ertale in Ethiopia.**
- **Dormant(Sleeping) volcanoes: volcanoes that are currently inactive but have the potential to erupt again in the future. Example, Mt. Kilimanjaro, Tanzania.**
- **Extinct volcanoes: are considered to be permanently inactive and are not expected to erupt in the future. Example, Mt. Ziqualla, Ethiopia.**

- **Volcanoes can be classified based on their shape and size. Among the most common types are:**
- **1. Shield volcanoes: are volcanoes that have a low, but broad profile created by highly fluid lava flows that spread over wide areas.**
- **When a shield volcano erupt, basalt can flow great distance away from the vent to produce broad gentle slope. Shield volcanoes are known for their large size and low angle size. Example, The Hawaiian Islands.**

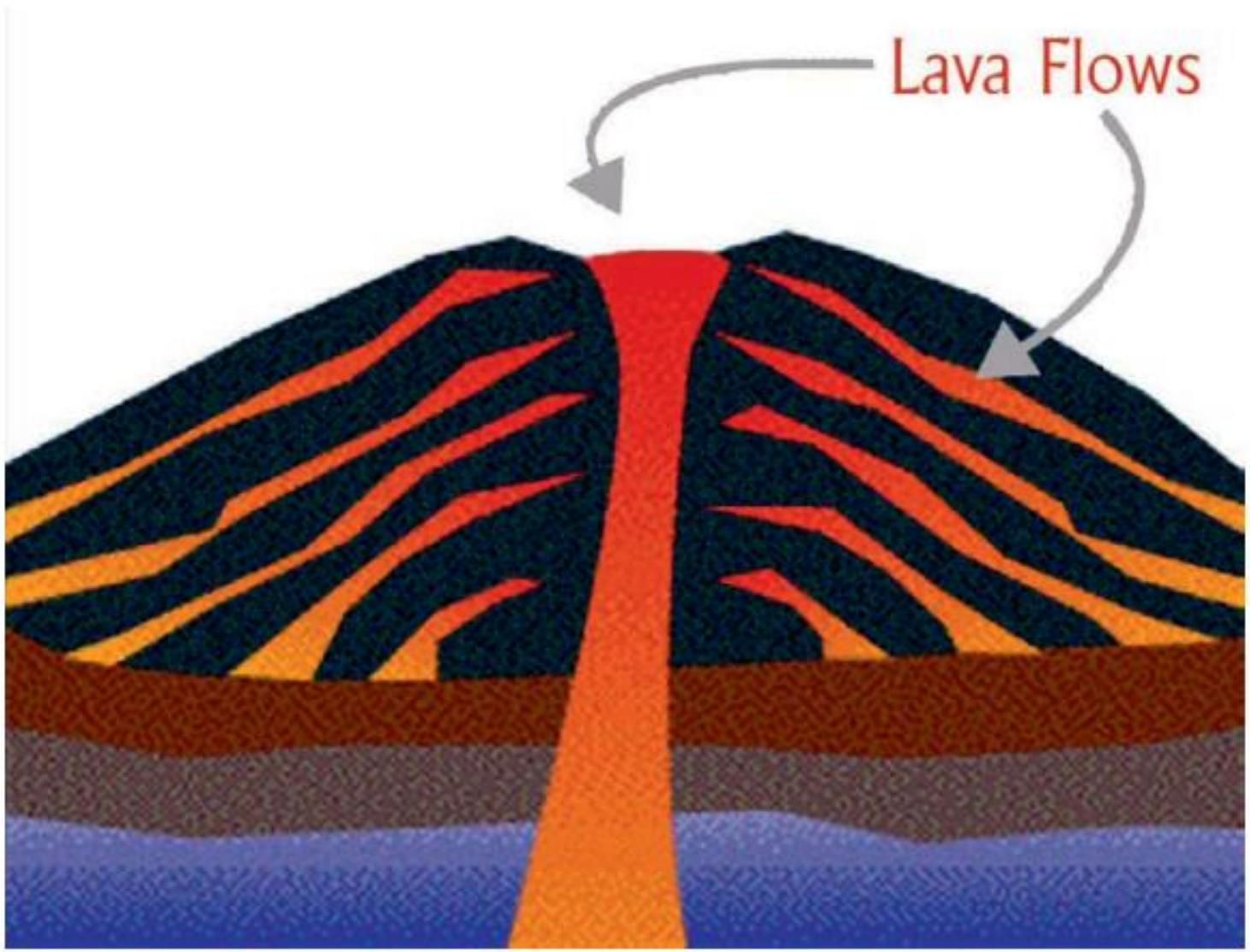


Figure 1.19: Shield volcano

- **2. Strata(Composite) volcanoes: they are the most common volcanic form.**
- **They are tall, conical volcanoes composed of alternating layer of lava, ash and pyroclastic materials.**
- **they are characterized by a steep profile and periodic, explosive eruption. The lava that flows from them is highly viscous and cools and hardens before spreading very far.**

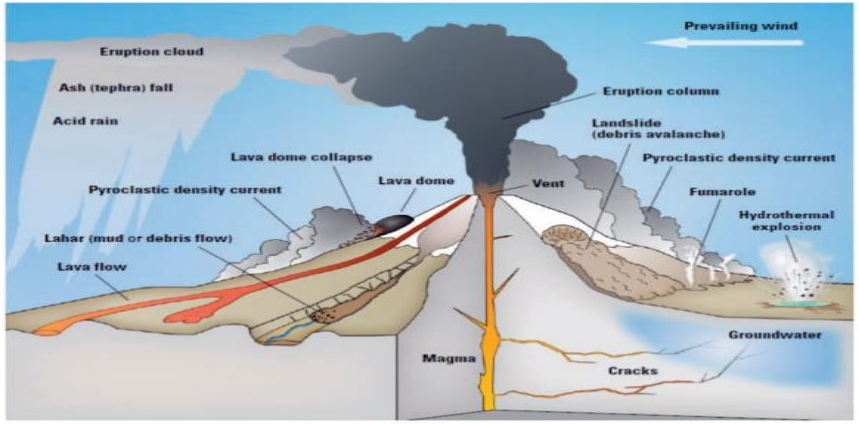


Figure 1.20: Strato volcanoes

- **3. Cinder cone volcano: is a conical hill of mostly cinder-sized pyroclastic.**
- **They are small steep- sided volcanoes. They usually are created of erupting on from a single opening.**

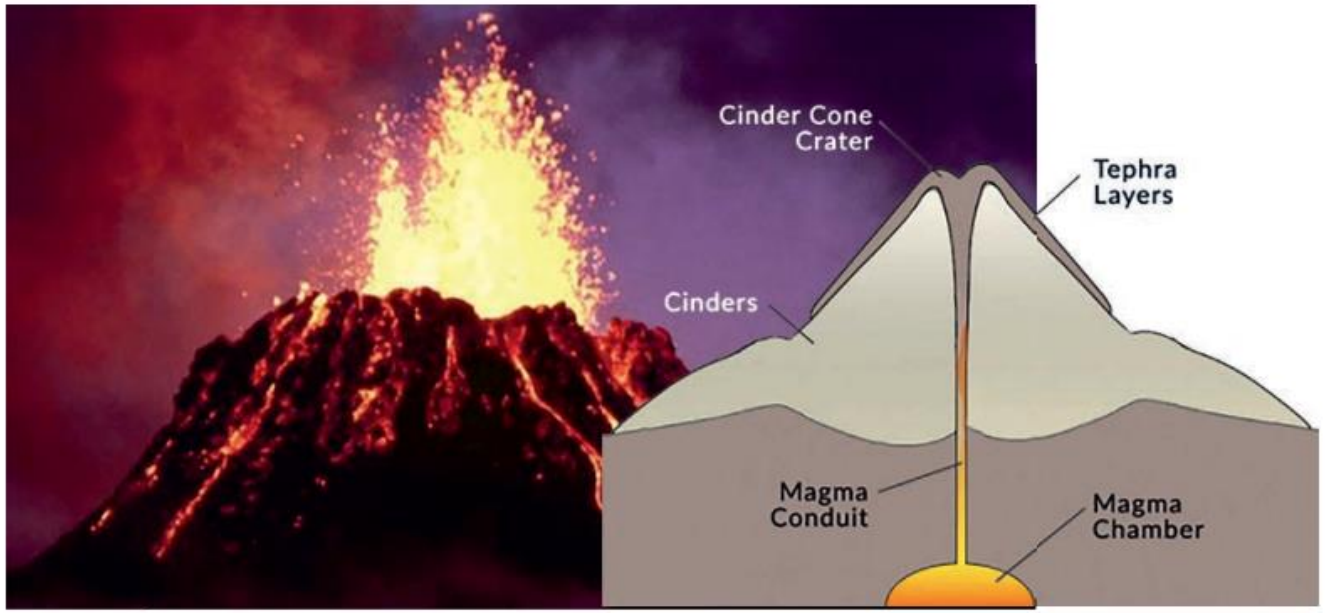


Figure 1.21: Cinder cone volcano

- **4. Craters: circular funnel shaped depression produced by volcanic eruption.**
- **They are created by various volcanic process, including explosive eruption and collapse of the volcanic cones.**

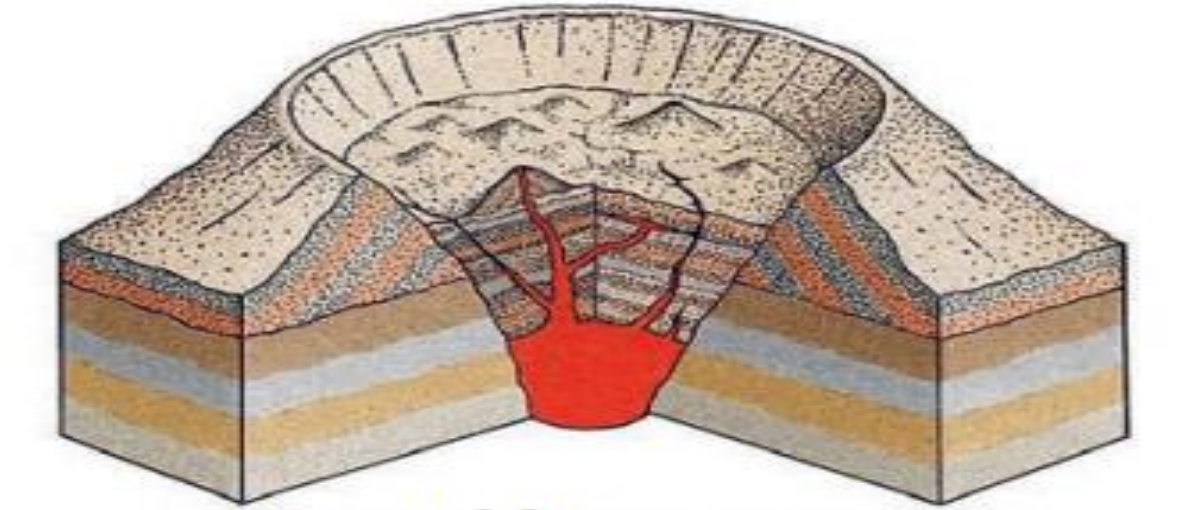


Figure 1.22:Crater volcano

- **5. Calderas: Calderas are large, crater basin-shaped depressions that form due to the collapse of the ground following a major eruption or the emptying of the magma chamber.**



Figure 1.23: Calderas; Segara Anakan Crater Lake, Rinjani Mt., Indonesia

Landforms Associated with Volcanism

- **Extrusive volcanic landforms: these are volcanic landforms forms on the earth's surface. The product of extrusive volcanic landforms include volcanoes, crater, caldera and lava plateaus.**
- **Intrusive(Plutonic)landforms: these are volcanic landforms formed when magma cools and solidifies within the crust.**
- **some of the intrusive igneous rocks include batholith, laccolith, sill and dyke.**
- **A Batholith: is a very large dome shaped intrusion of igneous rock that is accumulated deep in the crust.**

- **A laccolith: a mushroom(umbrella)shaped body of intrusive rocks which is accumulated nearer to the surface.**
- **A dike: is formed when magma solidifies a near vertical crack.**
- **A sill: is formed when magma solidifies horizontally or nearly horizontally along a bedding plane.**

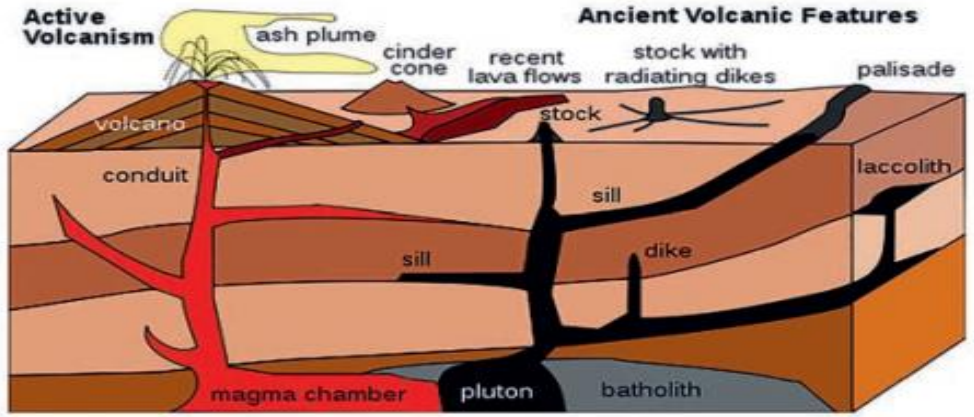


Figure 1.24: Batholith, Sill and Dike

1.4.2. External (Exogenic) Forces

- **They are forces that act on the surface of the earth from the outside. These forces/agents include running water, wind, moving ice, sea waves, etc.**
- **External forces can level up and down of the earth. External process occurs in two ways:**
  1. **Denudation and**
  2. **Deposition**
- **Denudation: is the lowering of the land by wearing away the surface of the earth.**
- **Denudation consists of Weathering and Erosion.**

- **Weathering: Weathering refers to the gradual break down of rocks into pieces. Weathering of rocks takes place in two ways. They are;**

  1. Physical (Mechanical) weathering

  2. Chemical weathering

Physical (Mechanical) weathering

- **Physical weathering is the process by which rocks are broken into smaller pieces. Each fragment has similar chemical characteristics like the original.**
- **The major agents(causes) of physical weathering are:**

- ❖ i). Thermal expansion and contraction(Temperature change)
- ❖ ii). Frost action
- ❖ iii). Plant and animal action

- ➢ **Thermal expansion and contraction: in hot and dry areas, the temperature variation between day and night causes rock to expand and to contract. Due to this contraction and expansion process, the rock layer peel off and fall to the ground.**
- ➢ **The process of breaking of rock layers caused by change of temperature is called exfoliation(onion skin weathering).**



Figure I.25: Exfoliation

- **Frost action: if rain water in the crack of rocks freezes due to low temperature, it expand and pushes the side of the crack. Then the crack widen and deepen. Finally the rock break up into pieces. Then, the fragments collect around the lower slopes of the rocks. Such rock collection are called screes.**
- **Frost action is very common in the cooler areas of the world(higher latitude).**

- **Plants and animals action: when the roots of some plant grow, it need more space. Thus, it cracks and break down the rock into pieces.**
- **Moreover, creatures such as fox, rabbits, worms, etc. dig the ground to find food and shelter. While doing this, they break up rocks.**

Chemical weathering

- **This involves complete changes in the internal structure of rocks. It is a process that forms new substances, and it is affected by the minerals in the rock.**

- **Chemical weathering can occur because of:**
  - **i. Rain action**
  - **ii. Plants and animals**
- **Rain action: Water is the most important agent of chemical weathering. As rain water passes through the atmosphere, it takes in carbon dioxide and forms a weak carbonic acid. When this acidic water comes into contact with rock, it begins to dissolve minerals in rock.**
- **For example, limestone dissolve very quickly. This process known as carbonation.**

- **Carbonation** is a process of chemical weathering whereby rainwater dissolve carbon dioxide on limestone areas.
  - $H_2O + Co_2 \rightarrow$ Carbonic acid $\rightarrow$ dissolves and erodes limestone and forms cave.

    Example, Sofomer cave along the river Weiyb in bale
- Underground cave in a limestone area contains feature such as stalactite, stalagmite and pillar.
- **A stalactite**: is a limestone column that hangs down from the ceiling of the cave.
- **A stalagmite**: is a limestone column that builds up from the floor of the cave.

- **A Pillar: is formed when stalactite and stalagmite join together.**

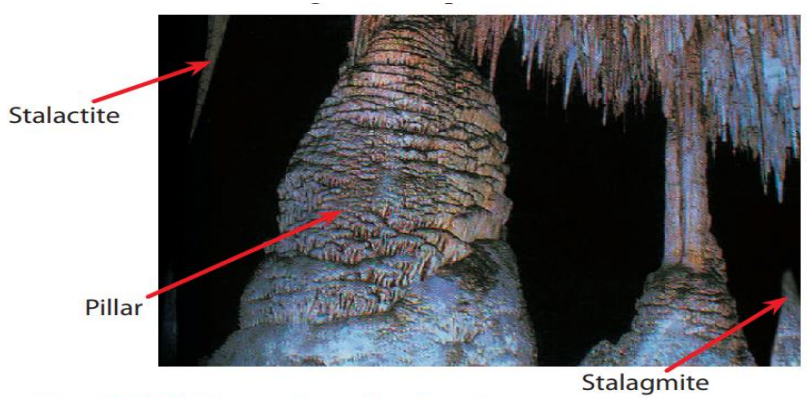


Figure 2.19 **Underground cave in a limestone area**

- **Plant and animals action: plants absorb minerals and decaying vegetation produce organic acid that caused a further break down of minerals.**
- **Bacteria in the presence of water break down certain minerals in the soil.**

Erosion and Deposition

- **Soil erosion is the movement of soil and rock particles from one place to another.**
- **The major agents of erosion include: Running water, Underground water, Wind, Sea waves, and Glaciers.**

Running water erosion

- **Running water includes all sorts of water that flows on the surface of the earth.**
- **Among the external forces, running water is more powerful in shaping the surface of the earth.**

- **The ability of running water to erode and transport materials is directly related to its speed.**
- **Running water flowing along a steep slope is very powerful. Therefore, it can wear and tear the land surface strongly.**
- **The rate of erosion by running water also depends on vegetation cover. Areas that have rich vegetation cover are less affected by erosion.**

Types of running water erosion

- **There are three types of running water erosion: Sheet, Rill and Gully erosion.**

- **1. Sheet erosion: it occurs when the surface water move in a wide flow. This moving water erodes top soil evenly. It results in the removal of a uniform depth of top soil.**
- **2. Rill erosion: it occurs when the surface water cuts small channels or ditches in the soil.**
- **3. Gully erosion: occurs when the floods cut deep wide gorges(channels). Gully erosion can become sever where all or most of the vegetation has been removed.**



Figure 1.27: Landforms associated with running water: Sheet, Rill and Gully erosion, respectively from left to right.

Landform associated with a river course

- The course of a river, from its source to its mouth, can be divided into 3 stages: upper, middle and lower course of a river.

Landforms associated with the upper course of a river

- In its upper course, a river is swift and strong. And therefore, it cuts a deep gorge or canyon.
- Types of upper course landforms includes:
  - "V" Shaped valley
  - Gorge
  - Rapids and waterfalls
  - Interlocking spur



Figure 1.28: Landforms associated with the upper course of a river, V-shaped valley, gorge, Interlocking spurs, Rapids and Waterfalls

Landform associated with a middle course of river

- **In this part, the river valley becomes wider and larger.**
- **The volume of water increases because many tributaries that join the main river. The place where a tributary joins the main river is called confluence.**
- **Types of middle course landforms includes:**
  - **Meanders: It is the winding of a river.**
  - **Ox-bow Lake: It is a crescent moon shaped lakes crated due to meander.**



Figure 1.29: Landforms associated with a middle course of river, Meanders and Ox-bow Lake, respectively from the left to the right

Landform associated with the lower course of a river

- **In its lower course, a river flows slowly. It has a wide and flat-floored valley.**
- **The main activity of the river in this course is deposition.**
- **Major landforms associated along a river course include:**
  - **Flood plain: It is a land surface formed from sediments deposited along the banks of the lower course of a river.**
  - **Delta: It is a triangular piece of land found at the mouth of a river.**



Figure 1.30 : Landforms associated with the lower course of a river; Flood plain & Delta, respectively from the left to the right.

Wind Erosion and Deposition

- **Wind action is very powerful in desert and semi-desert areas.**
- **Wind erosion and deposition forms different landforms such as:**
  - **Sand dunes: are little or small hills of sand formed by the action of wind.**
  - **Barkhan: is a small hill of sand that has a crescent moon shaped.**
  - **Loess deposits: are fertile soils in deserts deposited by wind. There are large loess deposits in North China.**

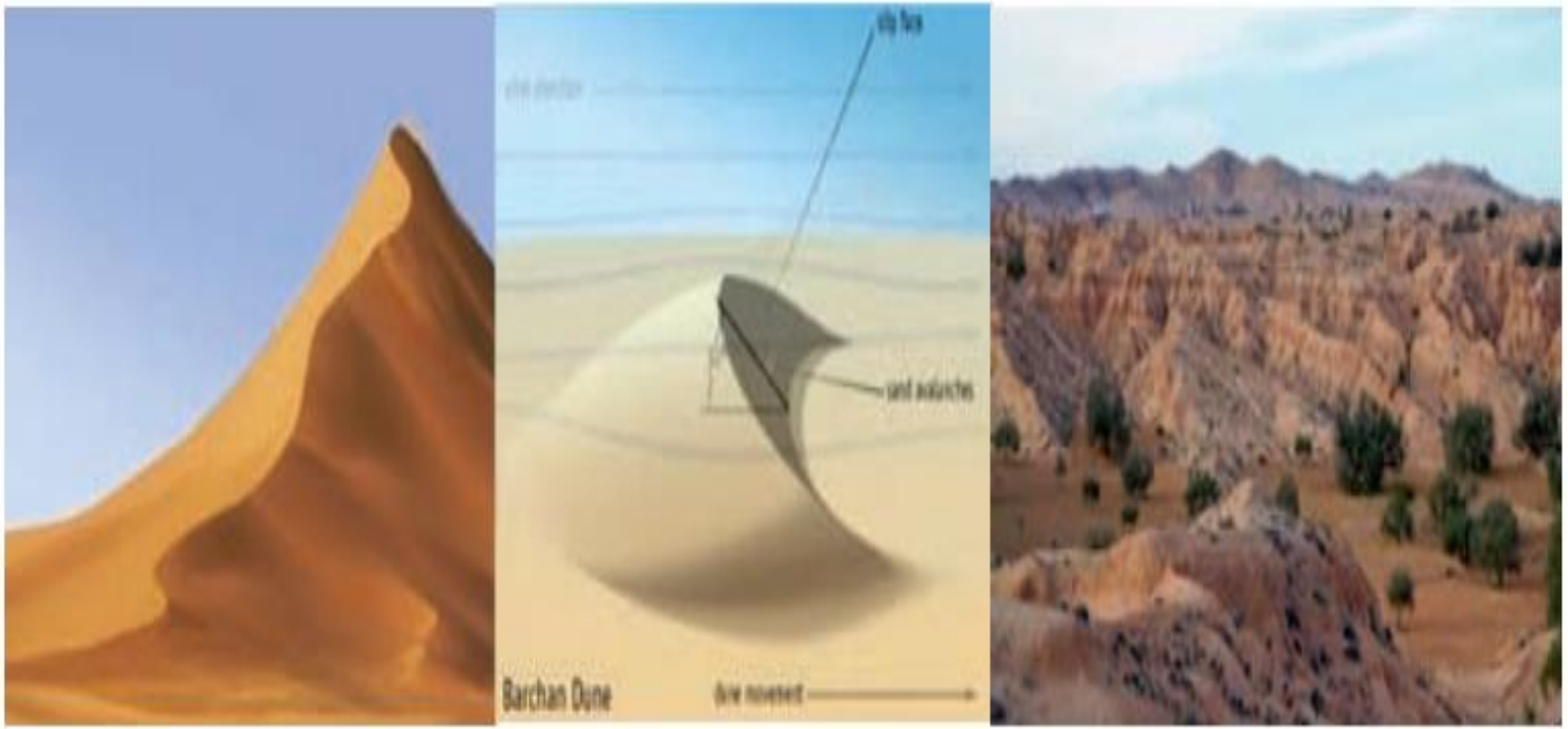


Figure 1.31: Wind action; Sand dunes, Barkhan, Loess de-

Erosion and Deposition by Sea waves

- **The sea water performs both erosion and deposition activities.**
- **Features formed by the work of the sea along the coastlands include:**
  - **Beach: is strip of land along the sea coast covered by varied types of sediments.**
  - **Spit: is a narrow ridge of sand. It projects into the sea but is attached to the land at one end.**
  - **Lagoon: is an area of salt water separated from the sea by loose sand banks**



Figure 1.32: The work of the sea beach, spit, lagoon left to right

Mass Wasting(Movement)

- **Mass Wasting refers to the down slope movements of rock, regolith, and soil under the influence of gravity.**
- **Actual gravity is the controlling factor for mass wasting. There are also other factors. The major ones are:**
  - **Water;**
  - **The angle of the slope, and**
  - **The activities of people.**
- **Water: water can increase the weight of the materials and reduced its frictional strength, making it more susceptible to mass wasting.**

- **The Angle of the slope: Steeper slope are more prone to mass wasting as the force of gravity is stronger on steeper gradient.**
- **The activities of people: People often create favorable conditions for mass wasting along steep and unstable slopes. This happens due to farming and overgrazing of the areas.**
- **In different parts of Ethiopia, mass wasting occurred several times. This phenomenon resulted in the destruction of human life and properties.**

Choose the best answer from the given alternatives

1. **In which of the following places does sea floor spreading occurs** **Q1**

   A. Eurasian plate **C. Mid-Atlantic Ridge**

   B. Marian Trench **D. North American Plate**

1. **All the following are formed at convergent plate margin <u>EXCEPT</u>** **Q2**

   A. Mid-oceanic ridge **C. Deep sea trench**

   B. Fold mountain **D. Island arc**

1. **Which of the following will result from two continental plates colliding?** **Q3**

   A. Mid-oceanic ridge **C. Deep sea trench**

   B. Island arc **D. Fold Mountains**

1. **Plates slide past each other at** **Q4**

   A. a hotspot **C. a convergent plate margin**

   B. a transform plate margin **D. a divergent plate margin**

1. **This layer of the earth is liquid in nature** **Q5**

   A. crust **C. outer core**

   B. mantle **D. inner core**

1. **What is the name of the Mesozoic supercontinent that consisted of all of the present continents?** **Q6**

   A. Eurasia

   B. Laurasia

   C. Pangaea

   D. Gondwanaland

1. **At a divergent plate margin the crustal plates** **Q7**

   A. move towards each other

   B. slide alongside each other

   C. move apart from each other

   D. sink one beneath the other

1. **Fold mountains form when plates of the earth's crust move** **Q8**

A. away from each other **C. towards each other**

B. parallel to each other **D. up and down**

1. **Plates move due to** **Q9**

A. Conventional currents **C. Constructive currents**

B. Compression currents **D. Convection currents**

1. **Which plate is being subducted beneath western South America?** **Q10**

A. the Pacific plate **C. the Nazca plate**

B. the South American plate. **D. the South Atlantic plate**

1. **Plate subduction occurs at** **Q11**

    A. Convergent plate boundaries

    B. Divergent plate boundaries

    C. Mid-oceanic ridges

    D. Transforming plate boundaries

1. **New oceanic lithosphere forms at** **Q12**

    A. divergent plate boundaries

    B. convergent plate boundaries

    C. transform plate boundaries

    D. all of these are possible

1. **At convergent plate boundaries where oceanic and continental crust meet** **Q13**

   A. no associated volcanism occurs

   B. oceanic crust is subducted

   C. continental crust is subducted

   D. oceanic crust is created

1. **Which is formed where the Eurasian and Indo -Australian plates meet** **Q14**

   A. Alps fold mountain **C. Himalayas fold mountain**

   B. Andes fold mountain **D. none of the above**

1. **At convergent plate boundaries where oceanic and continental crust meet** **Q15**

   A. no associated volcanism occurs

   B. oceanic crust is subducted

   C. continental crust is subducted

   D. oceanic crust is created

1. **Which is formed where the Eurasian and Indo -Australian plates meet** **Q16**

   A. Alps fold mountain

   B. Andes fold mountain

   C. Himalayas fold mountain

   D. Rockies fold mountain

1. **Which is formed where the Eurasian and African plates meet** **Q17**

   A. Alps fold mountain **C. Himalayas fold mountain**

   B. Andes fold mountain **D. Rockies fold mountain**

1. **All are a part of southern Pangea (Gondwanaland) except** **Q18**

   A. Africa **B. Australia** **C. Europe** **D. South America**

1. **As dense basalt to oceanic crust,------- to continental crust** **Q19**

   A. Granite **B. Silicate** **C. Marble** **D. Slate**

1. **Who was the German scientist that formulated continental drift theory?** **Q20**

   A. Robert Hartshorne

   B. Thomas Malthus

   C. Waldmir Karl

   D. Alfred Wegener

1. **Which one of the following is <u>NOT</u> the evidence suggested by Alfred Wegener to make his theory acceptable?** **Q21**

   A. Fit of the continents

   B. the spreading of oceanic floor

   C. Match of the continents belt, rock type

   D. Distribution of fossil

1. **Weathering refers to** **Q22**

   A. **The lowering of the land by wearing away the surface of the earth**

   B. **The process by which rocks are breaking in to smaller pieces**

   C. **The process of magma forced out on the surface**

   D. **The final result of erosion**

2. **A limestone column that hangs down from the ceiling of a cave is called** **Q23**

   A. **Stalactite**

   B. **Pillar**

   C. **Stalagmite**

   D. **Scree**

1. **Landforms associated with the upper course of the river** **Q24**

   A. Tributaries and confluence

   B. Meanders and U- shaped valley

   C. Delta and flood plain

   D. Rapid and waterfalls

1. **Spit, beach and lagoon are associated with** **Q25**

   A. Wind B. seas C. rivers D. glaciers

1. **Sofomer cave in Bale formed as a result of** **Q26**

   A. Chemical weathering C. Mechanical weathering

   B. Physical weathering D. Onion peels off weathering

1. **Which one of the following physical weathering is common in higher latitude areas of the world? Q27**

   A. Exfoliation **C. Onion skin weathering**

   B. Frost action **D. Carbonation**

1. **A volcanoes that have not erupted during historic time but, will probably erupt again. Q28**

   A. Active volcanoes **C. Dormant volcanoes**

   B. Extinct volcanoes **D. Dead volcanoes**

1. **A large crater basin shaped depression that form due to the collapse of the ground following a major eruption. Q29**

   A. Vent **B. Caldera** **C. Fissure** **D. Lava plateau**

1. **Which one of the volcanoes are formed from viscous, sticky lava that does not flow easily? Q30**

   A. Shield volcanoes
   C. Strata volcanoes
   B. Cinder cone volcanoes
   D. Caldera

1. **Which one of the following is NOT true about strata volcanoes? Q31**

   A. They are the most common volcanic form.
   B. They are more cone shaped volcanoes
   C. They are known for their large size and low angle slope
   D. They are C/zed by a steep profile and periodic, explosive eruption

1. **Which one of the following features associated with a subduction zone? Q32**

   A. Volcanic arc **C. Island arc**

   B. Oceanic trench **D. All of the above**

1. **It is a portion of the earth's mantle that flows like molten plastic despite being solid. Q33**

   A. Lithosphere **C. Asthenosphere**

   B. Oceanic crust **D. Continental crust**

1. **A circular funnel shaped depression produced by volcanic eruption? Q34**

   A. Crater **B. Fissure** **C. Volcano** **D. Plateou**

1. **A bout 90% of the earth's earthquake occur along** **Q35**

   A. The pacific ring of fire

   B. Along the Great Rift valley of East Africa

   C. A belt between Europe and North Africa

   D. Along the mid oceanic ridge

1. **The type of erosion which results in a uniform removal of surface soil over a large area is called** **Q36**

   A. Sheet erosion **C. Rill erosion**

   B. Gully erosion **D. Valley erosion**

1. **When stalactite and stalagmite converge at a point, resulting land feature is referred to as** **Q37**

   A. Margin B. Pillar C. Edge D. Ridge

1. **When the land between parallel faults sinks down, the remaining part of the earth in either side of the crack is called** **Q38**

   A. Block mountain **C. Fold mountain**

   B. Plateau **D. Rift valley**

1. **Which one is differ from the others?** **Q39**

   A. Meanders B. Gorge C. Waterfall D. Spring

1. **Which one of the following Richter's scale of earthquake magnitude shows total destruction? Q40**

   A. 6 B. 7 C. 5 D. 9

1. **What is the causes of the formation of screes? Q41**

   A. Chemical weathering C. Denudation

   B. Physical weathering D. Convection current

1. **Which one of the following pairs of landforms shows similar activities of due to erosion by river and sea? Q42**

   A. Gorge and sand dunes

   B. Flood plains and loess deposit

   C. Delta and beach

   D. Ox- bow lake and brakhan

1. **Which one of the following agents of physical weathering related to frost action?** **Q43**

   A. Exfoliation **C. Scree**

   B. Stalagmite **D. Stalactite**

1. **Which one of the following is the major characteristic of the upper course of a river?** **Q44**

   A. Slow movement of water

   B. Formation of confluence

   C. Formation of V- Shaped valley and water falls

   D. formation of Delta and flood plains

1. **Volcanism is the process by which** **Q45**
   - **A. Vibration from the crust of the earth spread out in the form of wave in all direction**
   - **B. Molten rock(magma) is forced out onto the surface of the earth**
   - **C. Young and old fold mountains are formed**
   - **D. Rift valley system is occurred**
2. **Which one of the following pairs belongs to old fold mountains?** **Q46**
   - **A. Andes, Rocky & Alps**
   - **B. Himalaya, Atlas & Rocky**
   - **C. Cape range & Urals**
   - **D. Atlas & Cape range**

1. **Block(horst) mountain is formed when** **Q47**
   - **A. The land between two parallel faults pushed upward due to pressure comes from inside the earth's crust.**
   - **B. The land between two faults sink down**
   - **C. Pressure is very great and fractures occur in the fold**
   - **D. Sudden vibration occur in the earth.**
2. **All are intrusive volcanic landforms except** **Q48**

   A. Batholith B. Dike C. Crater D. Laccolith

1. **Which one of the following is <u>NOT</u> related to endogenic forces ?** **Q49**
   - **A. Volcanism**
   - **B. Folding**
   - **C. Denudation**
   - **D, Earthquake**

1. **Which of the following internal forces is responsible for the formation of the Ethiopian rift valley? Q50**

   A. Earthquake
   C. Folding
   B. Volcanism
   D. Faulting

1. **Which one of the following IS NOT the effect of earthquake? Q51**

   A. Land slide and tsunamis
   B. Devastation of cities and fire
   C. Surplus production
   D. Loss of human and animals life

1. **Regarding of geographical distribution of Fold Mountains, which one of the following is correctly matched? Q52**

   A. Alps __ Asia **C. Andes___ north America**

   B. Atlas ___ north Africa **D. Rockies __ Europe**

1. **The point from which an earthquake wave originate is known as _____ Q53**

   A. Focus **B. Epicenter** **C. Magma** **D. Core**

1. **A strip of land along the sea coast covered by varied types of sediments. Q54**

   A. Beach **B. Lagoon** **C. Spit** **D. Delta**

1. **Mass wasting refers to** **Q55**

   A. **The lowering of the land by wearing away the surface of the earth**

   B. **The process by which rocks are breaking in to smaller pieces**

   C. **The process of magma forced out on the surface**

   D. **The down slope movements of rock, regolith, and soil under the influence of gravity.**

2. **The process of breaking of rock layers caused by change of temperature is called** **Q56**

   A. Exfoliation B. Scree C. Gorge D. Decomposition

1. **A transform faults is conservative boundaries , because; Q57**

   A. Crust is neither destroyed nor created.

   B. New crust is generated by magma pushing up from the mantle

   C. Converging plates will move beneath the other

   D. The discovery of the seafloor expansion

2. **A seismic waves that travel along the earth's surface and are responsible for much of the damage and destruction associated with earthquake. Q58**

   A. Surface wave B. Body wave C. P- wave D. S- wave

1. **Which one of the following features is NOT associated with subduction zones? Q 59**

   A. Volcanic arc
   C. Trench
   B. Island arc
   D. Flood plain

1. **Which one of the following is NOT the effect of earthquake? Q60**

   A. Land slide and tsunamis
   B. Devastation of cities and fire
   C. High yield of agricultural productivity
   D. Loss of human and animals life