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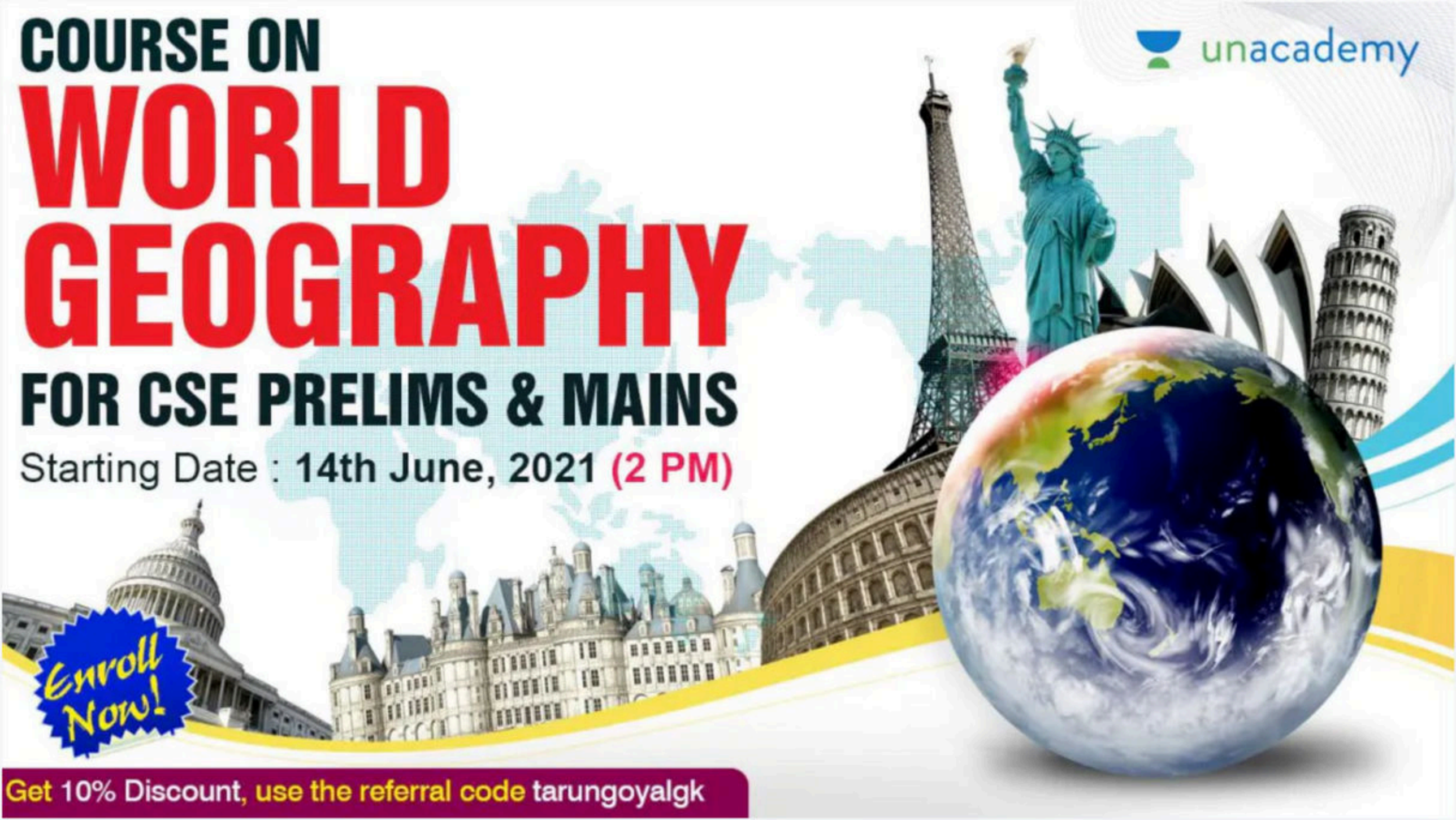
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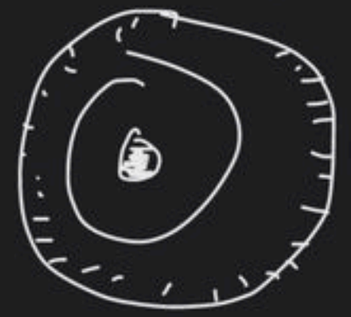
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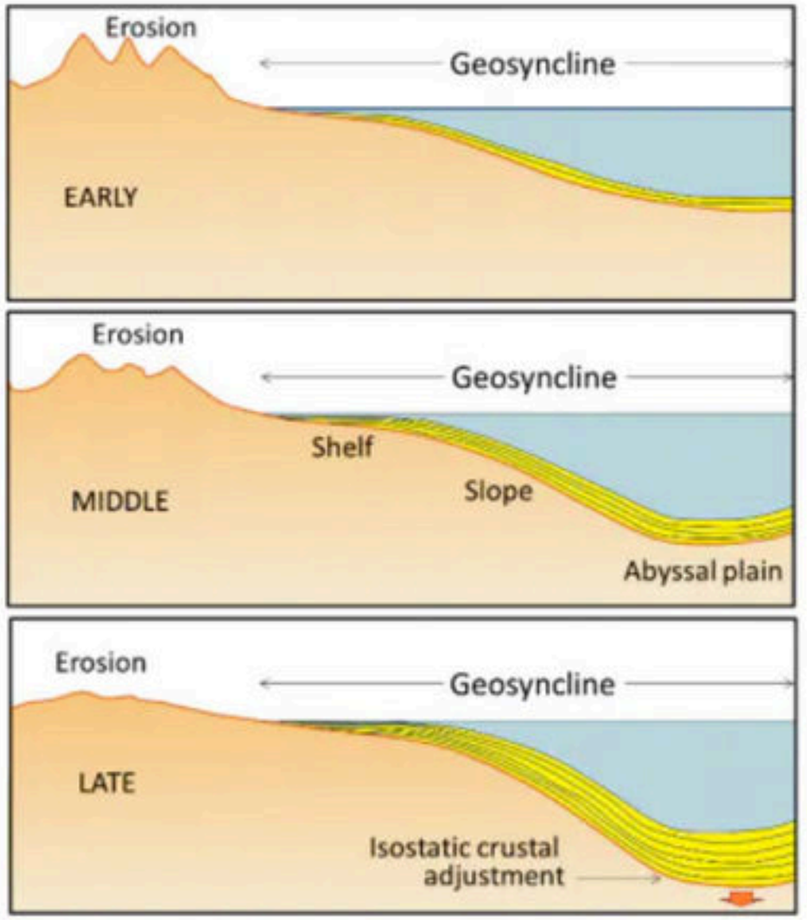
7 PM — Discussion

Cheat Notes → Concept

Dana & Hall : Hang

HONESTY

All about Geosynclines



by **Tarun Goyal**

The geological history of the continents and ocean basins denotes the fact that in the beginning, our globe was characterized by two important features viz.,:

(i) Rigid masses and

(ii) Geosynclines.

Rigid masses representing the ancient nuclei of the present continents, have remained stable for considerably longer periods of time.

These rigid masses are supposed to have been surrounded by mobile zones of water, characterized by **extensive sedimentation**. These mobile zones of water have been termed '**geosynclines'**, which have now been converted by compressive forces into folded mountain ranges.

On an average, a geosyncline means **a water depression characterized by sedimentation**. It has now been accepted by majority of the geologists and geographers that all the fold mountains have come out of the geosynclines and the rocks of the mountains originated as sediments were deposited and later on consolidated in sinking seas, now known as geosynclines.

If we consider the height and thickness of sediments of the young fold mountains of Tertiary period (e.g. Rockies, Andes, Alps, Himalayas, etc.), then it appears that the geosynclines should have been very deep water bodies, but the marine fossils found in the sedimentary rocks of these folded mountains belong to the category of marine organisms of shallow seas.

It is, thus, obvious that the geosynclines are **shallow water bodies characterized by gradual sedimentation and subsidence**.

Based on above facts, geosynclines can now be defined as :

'Geosynclines are long but narrow and shallow water depressions characterized by sedimentation and subsidence'.

J.A. Steers (1932) has aptly remarked, *"the geosynclines have been long and relatively narrow depressions which seem to have subsided during the accumulation of sediments in them."*

General Characteristics of Geosynclines

(a) Geosynclines are long, narrow and shallow depressions of water.

(b) These are characterized by gradual sedimentation and subsidence.

(c) The nature and patterns of geosynclines have not remained the same throughout geological history, rather these have widely changed. In fact, the location, shape, dimension and extent of geosynclines have considerably changed due to earth movements and geological process.

(d) Geosynclines are mobile zones of water.

(e) Geosynclines are generally bordered by two rigid masses which are called **forelands**.

Concept of Geosynclines

The concept of geosynclines was given by **James Hall** and **Dana,** but the concept was elaborated and further developed by **Haug**.

J.A. Steers (1932) has remarked, *"While the theory of geosynclines is due to Haug, the concept of idea belongs to Hall and Dana*."

1. Concept of Hall and Dana

Dana studied the folded mountains and postulated that the sediments of the rocks of folded mountains were of marine origin. These rocks were deposited in long, narrow and shallow seas.

Dana named such water bodies as geosynclines. He defined, for the first time, geosynclines as long, narrow and shallow and sinking beds of seas.

Hall elaborated the concept of geosynclines as advanced by Dana.

He presented ample evidences to show relationship between geosynclines and folded mountains. He opined that the rocks of folded mountains were deposited in shallow seas.

According to Hall, the beds of geosynclines are subjected to subsidence due to continuous sedimentation but the **depth of water in the geosynclines remains the same** (see figure). Geosynclines are much longer than their widths.

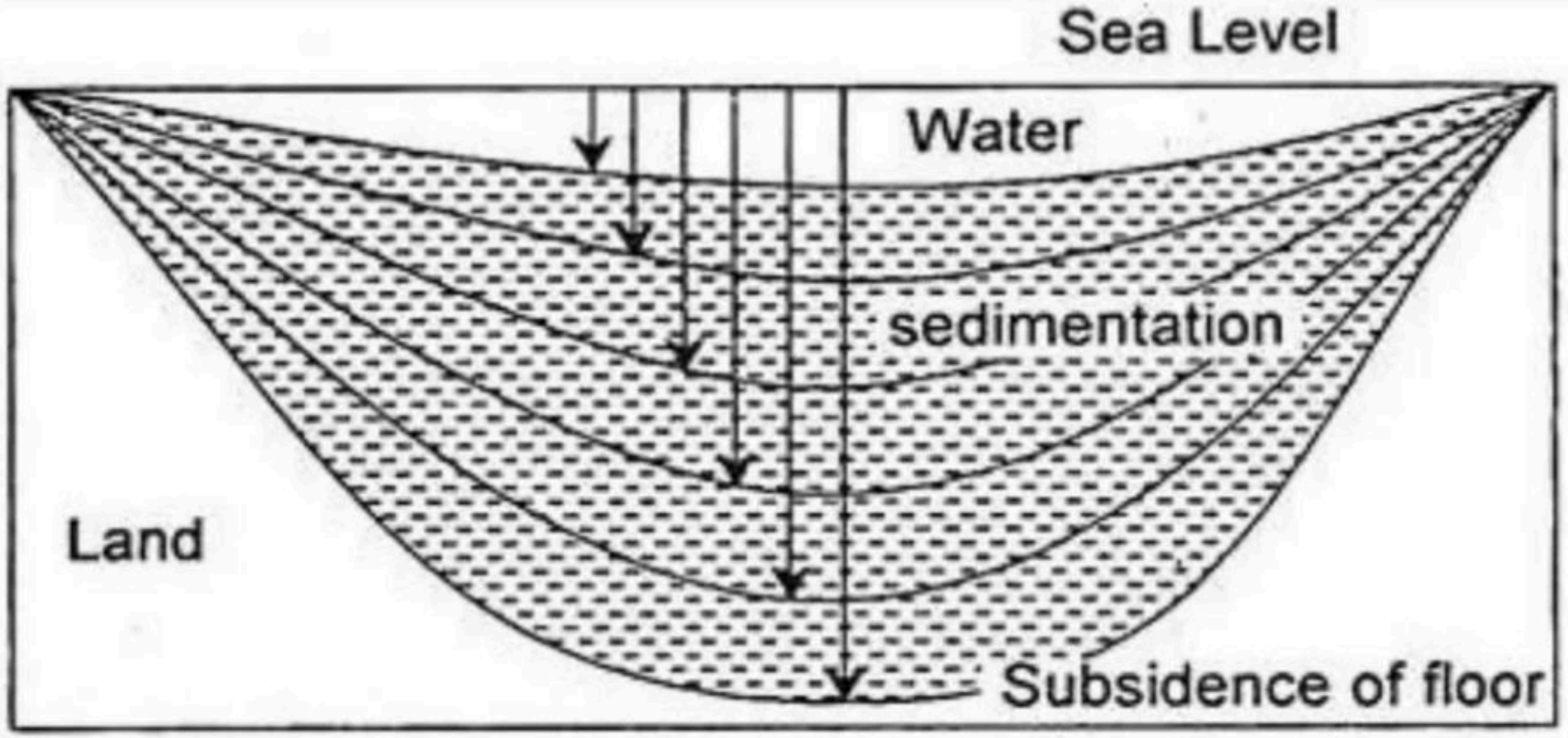


Fig. 11.2 : Sinking beds of geosynclines due to sedimentation and subsidence.

2. Concept of E. Haug

If the idea of geosynclines is due to Hall and Dana, the theory of their development is really due to Haug.

He defined geosynclines as long and deep water bodies. According to Haug, *"geosynclines are relatively deep water areas and they are much longer than they are wide"*.

He drew the palaeo-geographical maps of the world and depicted long and narrow oceanic tracts to demonstrate the facts that these water tracts were subsequently folded into mountain ranges (see figure).

He further postulated that the positions of the present-day mountains were previously occupied by oceanic tracts, i.e. geosynclines. Geosynclines existed as mobile zones of water between rigid masses.

He identified 5 major rigid masses during Mesozoic era :

(i) North Atlantic Mass,

(ii) Sino-Siberian Mass,

(iii) Africa-Brazil Mass,

(iv) Australia-India-Madagascar Mass, and

(v) Pacific Mass.

He located 4 geosynclines between these ancient rigid masses :

(i) Rockies geosyncline,

(ii) Ural geosyncline,

(iii) Tethys geosyncline, and

(iv) Circum-Pacific geosyncline.

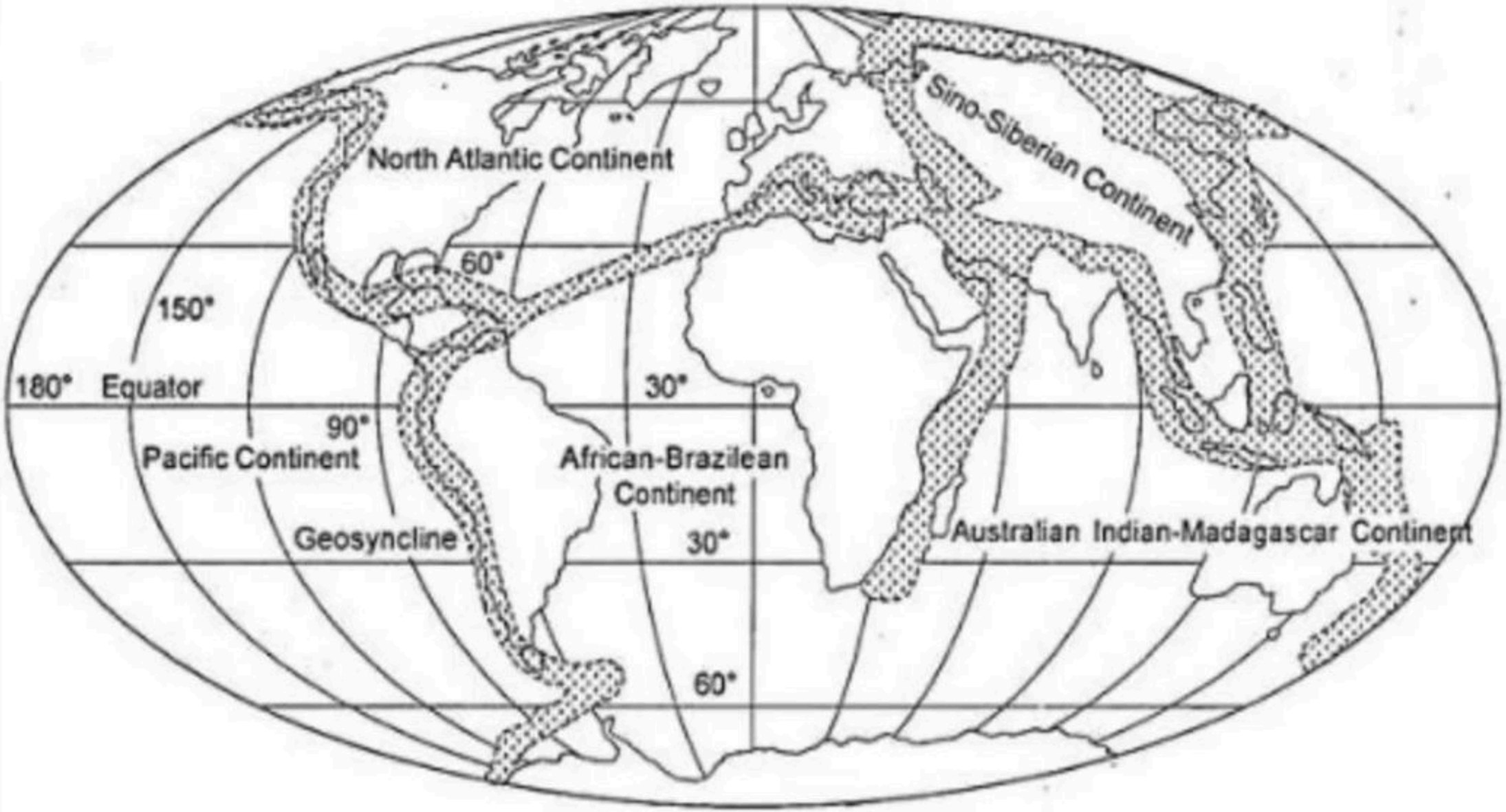


Fig. 11.3: Distribution of rigid masses and geosynclines during Mesozoic era as depicted by E. Haug.

According to Haug, there was systematic sedimentation in the geosynclines. The littoral margins of the geosynclines are affected by transgressional and regressional phases of the seas [a transgression is a landward shift of the coastline while regression is a seaward shift].

The marginal areas of the geosynclines have shallow water, wherein larger sediments are deposited, whereas finer sediments are deposited in central parts of the geosynclines [i.e., littoral margins have coarser sediments, the finer sediments are deposited in the centre].

The sediments are squeezed and folded into mountain ranges due to compressive forces coming from the margins of the geosynclines.

He has further remarked that it is not always necessary that all the geosynclines may pass through the complete cycle of the processes of **sedimentation, subsidence, compression and folding of sediments**. Sometimes, no mountains are formed from the geosynclines in spite of continuous sedimentation for long duration of geological time.

Though the contributions of Haug in this regard are praiseworthy as he developed the concept of geosynclines, but his **theory suffers from certain serious drawbacks** and confusing ideas about them. His palaeo-geographical map (in figure) of Mesozoic era depicted unbelievable larger extent of rigid masses (land areas) in comparison to geosynclines (oceanic areas).

Questions arise, as to what happened to such extensive land masses after Mesozoic era? Where did they disappear? Haug could not explain these and many more questions.

His geosyclines as very **deep oceanic tracts** are also not acceptable because the marine fossils found in folded mountains belong to the group of marine organisms of shallow seas.

3. Concept of J.W. Evans

According to Evans, the geosynclines are so varied that it becomes difficult to present their definite form and location.

The beds of geosynclines are subjected to gradual subsidence because of sedimentation. The form and shape of geosynclines change with changing environmental conditions. A geosyncline may be narrow or wide. It may be of different shapes.

There may be several alternative situations of geosynclines :

(a) It may be between two land masses (example, Tethys geosyncline between Laurasia and Gondwanaland),

(b) It may be in front of a mountain or a plateau (for example, resultant long trench after the origin of the Himalayas, this depression was later on filled with sediments to form Indo-Gangetic Plains),

(c) It may be along the margins of the continents,

(d) It may be in front of a river mouth, etc.

According to Evans, all the geosynclines irrespective of their varying forms, shapes and locations are characterized by **twin processes of sedimentation and subsidence**. Geosynclines, after long period of sedimentation, are squeezed and folded into mountain ranges.

4. Views of Schuchert

He attempted to classify geosynclines on the basis of their characteristics related to their size, location, evolutionary history, etc.

He has divided the geosynclines into **3 categories :**

(a) **Monogeosynclines**

They were exceptionally long and narrow but shallow water tracts as conceived by Hall and Dana.

The geosynclinal beds are subjected to continuous subsidence due to gradual sedimentation and resultant load.

Such geosynclines are situated either within a continent or along its borders. These are called **mono** because they pass through only one cycle of sedimentation and mountain building.

Appalachian geosyncline is considered to be the best example of this type. In place of the Appalachains, there existed a long and narrow Appalachain geosyncline during Pre-cambrian period (4.6 billion years ago (Ga) to the beginning of the Cambrian *Period,* about 541 million years ago). The geosyncline was bordered by highland mass known as Appalachia in the east. Appalachian geosynclines were folded from Ordovician to Permian periods.

(b) **Polygeosynclines**

They were long and wide water bodies. These were definitely broader than the monogeosynclines. These geosynclines existed for relatively longer period than the monogeosynclines and these have passed through complex evolutionary histories.

*"These are considered to have experienced more than one phase of orogenesis, consequently they may have been diversified by the production of one or more parallel geanticlines (*a large-scale upwardly flexed structure in the earth's crust*) arising from their floors in the squeezing process."*

They originated in positions similar to those of monogeosynclines. Rocky and Ural geosynclines are quoted as the representative examples of polygeosynclines.

(c) **Mesogeosynclines**

They were very long, narrow and mobile ocean basins which are bordered by continents from all sides. They are characterized by great abyssal depth and long and complex geological histories.

These geosynclines pass through several geosynclinal phases e.g., phases of sedimentation, subsidence and folding.

Mesogeosynclines are similar to the geosynclines conceived by Haug.

Tethys geosyncline is the typical example of such type. Mediterranean Sea is the remnant of Tethys geosyncline. This geosyncline was folded into Alpine mountains of Europe and the Himalayas of Asia. The unfolded remaining portion of Tethys geosyncline became Mediterranean Sea, an example of median mass of Kober.

5. Concept of Arthur Holmes

Besides describing main characteristics of geosynclines, Arthur Holmes has also elaborated the causes of the origin of different types of geosynclines.

He has also described the detailed processes and mechanisms of sedimentation and subsidence and consequent orogenesis.

According to him, no doubt sedimentation leads to subsidence, but this process cannot account for the greater thickness of sediments in geosynclines, rather earth movements can cause subsidence of high magnitude in the geosynclinal beds.

He further pointed out that the process of subsidence of the geosynclinal beds was not a sudden process rather it was a gradual process.

The deposition of sediments up to the thickness of 12,160 m in the Appalachian geosyncline could be possible during a long period of 30,00,00,000 years from Cambrian period to early Permian period at the rate of one foot of sedimentation every 7,500 years.

Holmes has **identified 4 major types of geosynclines** and has described the **mode of their origin separately** :

(a) Formation of Geosynclines due to Migration of Magma

According to Holmes, the **Crust** of the earth is composed of **3 shells of rocks**. Just below the outer thin sedimentary layer lies:

(i) **Outer Layer** of granodiorite (intrusive igneous rock similar to granite) (thickness, 10 to 12 km), followed by

(ii) an **Intermediate Layer** of amphibolite (thickness, 20-25 km), and

(iii) a **Lower Layer** of eclogite (a metamorphic rock formed when mafic igneous rock is subjected to high pressure) and some peridotite (a dense, coarse-grained ultramafic igneous rock consisting mostly of the silicate minerals olivine and pyroxene).

He has further pointed out that migration of magmas from the intermediate layer to neighbouring areas causes collapse and subsidence of upper or outer layer and thus is formed a geosyncline.

The present Coral Sea, Tasman Sea, Arafura Sea, Weddell Sea and Ross Sea have been quoted as typical examples of such geosyncline.

This concept of Holmes has been severely criticised because the transfer and displacement of magmas cannot cause subsidence to form geosynclines.

(b) Formation of Geosynclines due to Metamorphism

According to Holmes, the rocks of the lower layer of the crust, as referred to above, are metamorphosed due to compression caused by converging convective currents. This metamorphism increases the density of rocks, with the result the lower layer of the crust is subjected to subsidence and thus a geosyncline is formed.

Caribbean Sea, the western Mediterranean Sea and Banda Sea have been quoted as examples of this category of geosynclines.

This concept has been **rejected** on the ground that compression caused by convergent convective currents would not cause metamorphism, rather it would cause melting of rocks due to resultant high temperature.

(c) Formation of Geosynclines due to Compression

Some geosynclines are formed due to compression and resultant subsidence of outer layer of the crust caused by convergent convective currents.

Persian Gulf and Indo-Gangetic trough are considered to be typical examples of this group of geosynclines.

(d) Formation of Geosynclines due to Thinning of Sialic Layer

According to Holmes, there may be two possibilities if a column of rising convective currents diverges after reaching the lower layer of the crust in opposite directions:

(i) The sialic layer is stretched apart due to tensile forces exerted by diverging convective currents. This process causes thinning of sialic layer which results in the creation of a geosyncline. The former Tethys geosyncline is considered to have been formed in this manner.

(ii) Alternatively, the continental mass may be separated due to enormous tensile force generated by divergent convective currents. Former Ural geosyncline is supposed to have been formed due to this mechanism.

6. Geosynclinal Orogen Theory of Kober

Famous German geologist Leopold Kober has presented a detailed & systematic description of the surface features of earth in his book *Der Bau der Erde*.

His main objective was to establish relationship between ancient rigid masses or tablelands and more mobile zones or geosynclines, which he called **orogen**.

Kober not only attempted to explain the origin of the mountains on the basis of his geosynclinal theory, but he also attempted to elaborate the various aspects of mountain building e.g., formation of mountains, their geological history and evolution and development.

He considered the old rigid masses as the foundation stones of the present continents. According to him, present continents have grown out of rigid masses.

He defined the process of mountain building or orogenesis as that process which links rigid masses with geosynclines. In other words, **mountains are formed from the geosynclines due to the impacts of rigid masses**.

This theory is based on **forces of contraction produced by the cooling of the earth**.

He believes in the contraction history of the earth. According to J.A. Steers (1932) *"Kober is definitely a constructionist, contraction providing the motive force for the compressive stress".*

In other words, the **force of contraction generated due to cooling of the earth causes horizontal movements of the rigid masses or forelands which squeeze, buckle and fold the sediments into mountain ranges**.

Base of the Geosynclinal Orogen Theory

According to Kober, there were mobile zones of water in the places of present-day mountains. He called mobile zones of water as geosynclines or **orogen** (the place of mountain building).

These mobile zones of geosynclines were surrounded by rigid masses which were termed by Kober as **kratogen**.

The old rigid masses included Canadian Shield, Baltic Shield or Russian Massif, Siberian Shield, Chinese Massif, Peninsular India, African Shield, Brazilian Mass, Australian and Antarctic rigid masses.

According to Kober, mid-Pacific geosyncline separated north and south forelands which were later on foundered (fill with water) to form Pacific Ocean.

Eight morphotectonic units can be identified on the basis of the description of the surface features of the earth during **Mesozoic era** as presented by Kober :

(i) Africa together with some parts of Atlantic and Indian Oceans,

(ii) Indian-Australian land mass, (iii) Eurasia,

(iv) North Pacific continents,

(v) South Pacific continents,

(vi) South America and Antarctica etc.

Kober has identified **6 major periods of mountain building** :

Three mountain building periods, about which very little is known, are reported to have occurred during pre-Cambrian period. Palaeozoic era (541 to 251.902 million years ago) saw two major mountain building periods – the Caledonian orogenesis was completed by the end of Silurian period (443.8 to 419.2 million years ago) and the Variscan orogeny was culminated in Permo-Carboniferous period (about 300 million years ago).

The last (6^{th}) orogenic activity known as Alpine orogeny was completed during Tertiary Period (66 million to 2.6 million years ago).

Kober has opined that **mountains are formed out of geosynclines**.

According to Kober, geosynclines, the places of mountain formation (known as orogen) are long and wide water areas characterized by sedimentation and subsidence.

According to J.A. Steers (1932) *"Kober's views (on geosynclines and orogenesis) are, then, a combination of the old geosynclinal hypothesis of Hall and Dana, which was developed later by Haug, and his own views on orogenesis."*

Mechanism of the Geosynclinal Orogen Theory

According to Kober, the whole process of mountain building passes through three closely linked stages of **Lithogenesis**, **Orogenesis** and **Gliptogenesis** :

(i) **Lithogenesis** (the stage of creation of geosynclines, sedimentation and subsidence of the beds of geosynclines).

(ii) **Orogenesis** (the stage of squeezing and folding of geosynclinal sediments into mountain ranges),

(iii) **Gliptogenesis** (the stage of gradual rise of mountains, and their denudation and consequent lowering of their heights).

The first stage is related to the creation of geosynclines due to the force of contraction caused by cooling of the earth. This preparatory stage of mountain building is called lithogenesis. The geosynclines are long and wide mobile zones of water which are bordered by rigid masses, which have been named by Kober as forelands, or kratogen.

These upstanding land masses or forelands are subjected to continuous erosion by fluvial processes and eroded materials are deposited in the geosynclines. This process of sediment deposition is called sedimentation.

The ever increasing weight of sediments due to gradual sedimentation exerts enormous pressure on the beds of geosynclines, with the result the beds of geosynclines are subjected to gradual subsidence. This process is known as the process of subsidence.

These twin processes of sedimentation and resultant subsidence result in the deposition of enormous volume of sediments and attainment of great thickness of sediments in the geosynclines.

The second stage is related to mountain building and is called the stage of orogenesis.

Both the forelands start to move towards each other because of horizontal movements caused by the force of contraction resulting from the cooling of the earth.

The compressive forces generated by the movement of forelands together cause contraction, squeezing and ultimately folding of geosynclinal sediments to form mountain ranges.

The parallel ranges formed on either side of the geosyncline have been termed by Kober as *randketten* (marginal ranges) (see figs).

According to Kober, folding of entire sediments of the geosyncline or part thereof depends upon the intensity of compressive forces.

If the compressive forces are normal and of the moderate intensity, only the marginal sediments of the geosyncline are folded to form two marginal randketten (marginal ranges) and middle portion of the geosyncline remains unaffected by folding activity (thus remains unfolded).

This unfolded middle portion is called zwischengebirge (or **Median Mass**) (see II fig).

Alternatively, if the compressive forces are acute, the whole of geosynclinal sediments are compressed, squeezed, buckled and ultimately folded (see fig) and both the forelands are closeted.

This process introduces complexity in the mountain because acute compression results in the formation of recumbent folds and nappes.

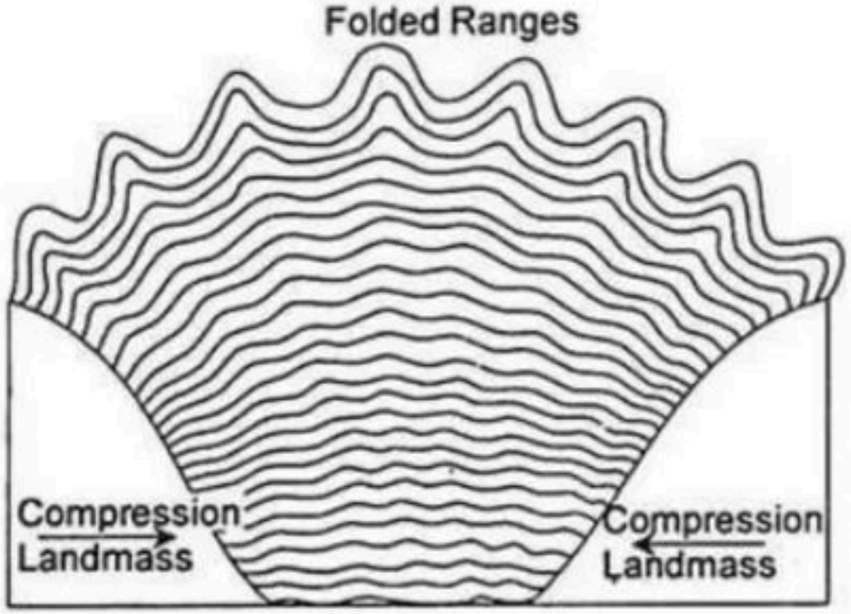


Fig. 11.6: Folding of marginal sediments into marginal ranges and formation of median mass when the compressive forces are moderate.

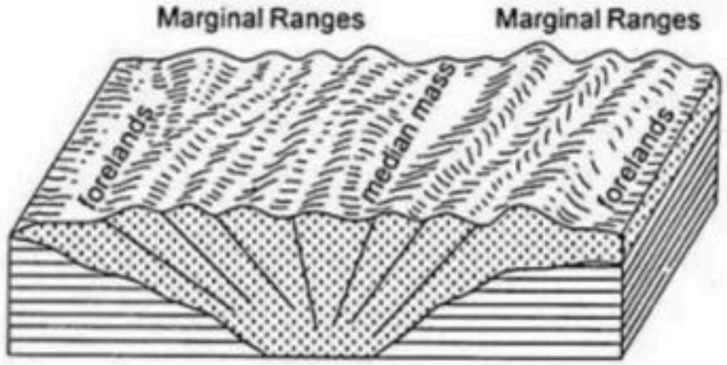


Fig. 11.7: Illustration of Kober's geosynclinal theory of mountain building through a block diagram.

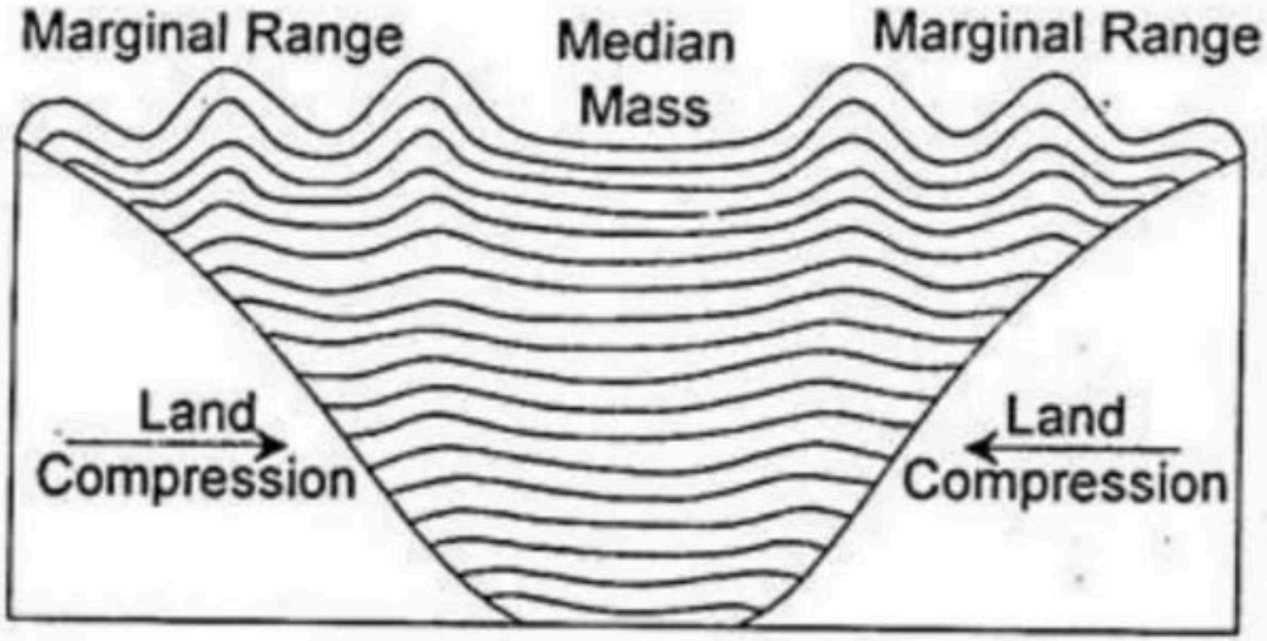


Fig. 11.5: The stage of orogenesis: squeezing and folding of geosynclinal sediments due to compressive forces; the whole of geosyndinal sediments are folded when the compressive forces coming from the sides of geosyncline is enormous and acute.

Three stages of Mountain Building

1. Lithogenesis
2. Orogenesis
3. Gliptogenesis

Four Terms Used by Kober

1. Orogen
2. Kratogen
3. *Randketten*
4. *Zwischengebirge*

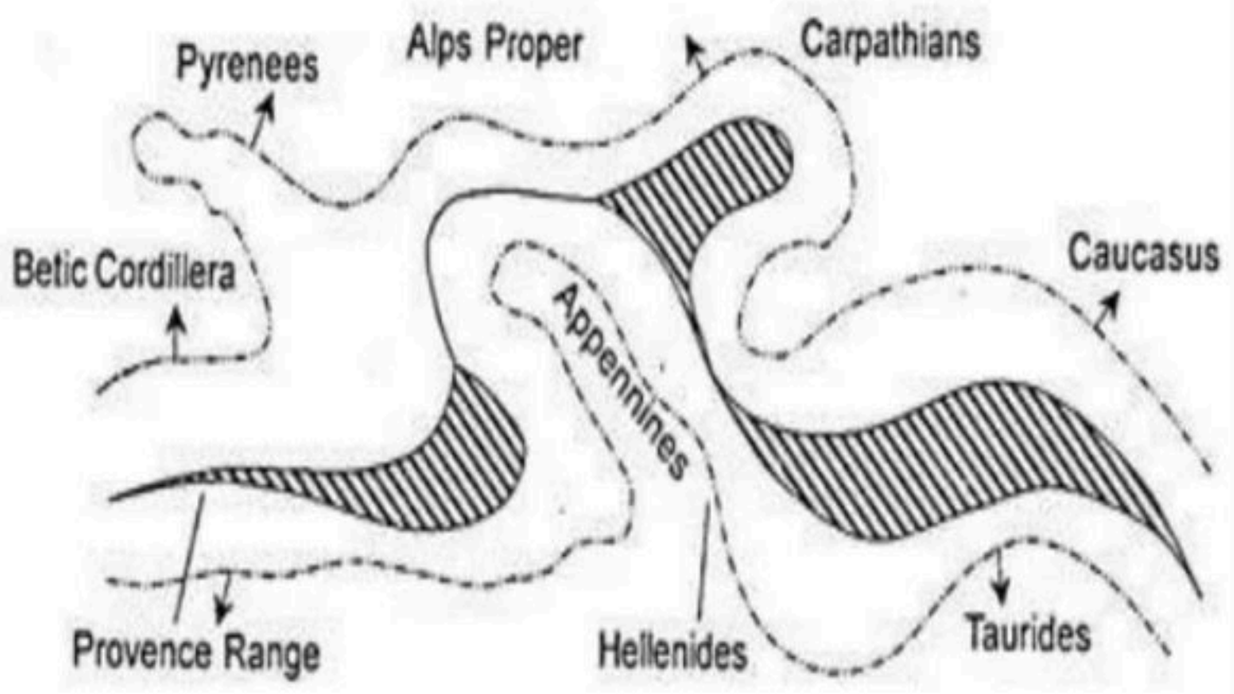

NORTH AMERICA
EUROPE
NORTH ATLANTIC OCEAN
NORTH PACIFIC OCEAN
NORTH PACIFIC OCEAN
Sahara Desert
AFRICA
CHINA
SOUTH AMERICA
INDIAN OCEAN
AUSTRALIA
SOUTH ATLANTIC OCEAN
SOUTH PACIFIC OCEAN
N

Kober has attempted to explain the forms and structures of folded mountains on the basis of his typical **median mass**.

According to Kober, the Alpine mountain chains of Europe can well be explained on the basis of median masses. According to him, *"Tethys geosyncline was bordered by European land mass in the north and by African rigid mass in the south. The sediments of Tethys geosycline were compressed and folded due to movements of European landmass (foreland) and African rigid mass (foreland) together in the form of Alpine mountain system. The Alpine mountain chains were formed because of compressive forces coming from two sides (north and south)."*

The median masses located in the Alpine mountain system very well explain the mechanism of mountain building.

The direction of folding in the Carpathians and Dinaric Alps (Dinarides) is north and south respectively, which means that Hungarian median mass is located between two mountain ranges having opposite directions of folding.



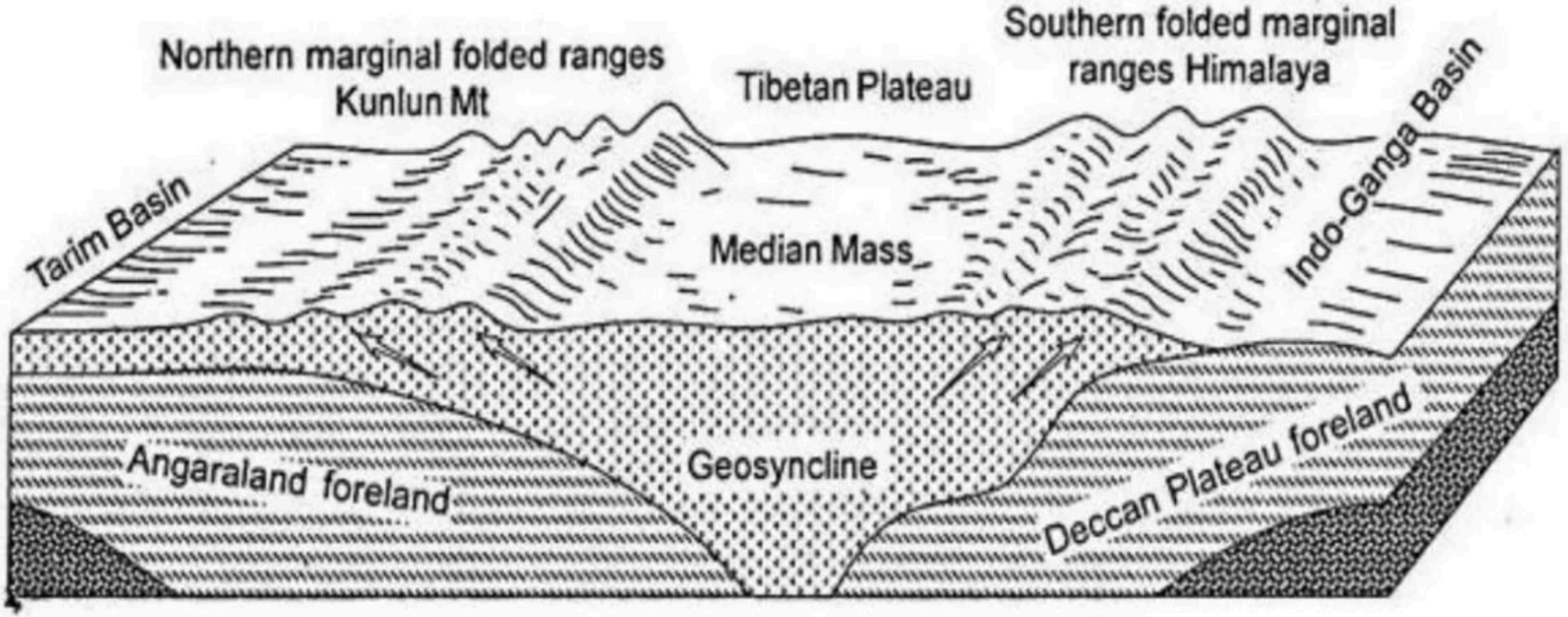


Fig. 11.9 : Illustration of Kober's median mass through Tibetan plateau between Kunlun and Himalaya.

According to Kober, **Asiatic Alpine folded mountains can be grouped into two categories on the basis of orientation of folds** :

(i) The ranges, which were formed by the northward compression, include Caucasus, Pantic and Taurus (of Turkey), Kunlun, Yannan and Annan ranges, and

(ii) The ranges, which were formed by the southward compression, include Zagros and Elburz of Iran, Oman ranges, Himalayas, Burmese ranges etc. Tibetan plateau is a fine example of median mass between Kunlun-Tien-Shan and the Himalayas.

The median mass may be of various forms :

(i) In the form of **plateau** (examples, Tibetan plateau between Kunlun and Himalaya. Iranian plateau between Zagros and Elburz, Anatolian plateau between Pantic and Taurus, Basin Range between Wasatch ranges and Sierra Navada in the USA);

(ii) In the form of **plain** (example, Hungarian plain between Carpathians and Dinaric Alps), and

(iii) In the form of **seas** (examples, Mediterranean Sea between African Atlas mountains and European Alpine mountains, Caribbean Sea between the mountain ranges of middle America and West Indies).

Third stage of mountain building is characterized by gradual rise of mountains and their denudation by fluvial and other processes. Continuous denudation results in gradual lowering of the height of mountains.

Evaluation of the Geosynclinal Orogen Theory

(a) The force of contraction, as envisaged by Kober, is not sufficient to cause mountain building. In fact, very extensive and gigantic mountains like the Alps, the Himalayas, the Rockies and the Andes cannot be formed by the force of contraction generated by cooling of the earth.

(b) According to Suess, only one side of the geosyncline moves whereas the other side remains stable. The moving side has been termed by Suess as **backland** whereas stable side has been called **foreland**. According to Suess, the Himalayas were formed due to southward movement of Angaraland. The Gondwanaland remained stationary.

This observation of Suess gained much favour previously but after the postulation of plate tectonic theory, his views have become meaningless and the concept of Kober, that both the forelands move together, has been validated because ample evidences of palaeomagnetism and sea-floor spreading have shown that both Asiatic and Indian plates are moving towards each other.

(c) Kober's theory somehow explains the west-east extending mountains but north-south extending mountains (Rockies and Andes) cannot be explained on the basis of this theory.

In spite of a few inherent limitations and weaknesses, Kober is given credit for advancing the idea of the formation of mountains from geosynclinal sediments because geosyncline found berth in almost all the subsequent theories even in plate tectonic theory.

7. Thermal Contraction Theory of Jeffreys

Jeffreys, a strong exponent of contraction theory, postulated his 'thermal contraction theory' to explain the origin and evolution of major reliefs of the earth's surface (continents, ocean basins, mountains, island arcs and festoons), but his major objective was to explain the origin and distributional patterns of mountain systems of the globe.

Jeffreys was a contractionist. His theory was based on mathematical reasoning.

He postulated his contraction theory because he could not find any strong reasons in the continental drift theory which advocated horizontal movement of the continents due to tidal force of the sun and the moon and the gravitational force as envisaged by A.G. Wegener.

Jeffreys used the force of contraction resulting **partly from cooling of the earth** due to loss of heat through radiation from the earth's surface and **partly from the decrease of the speed of the earth's rotation**.

In fact, the forces invoked by Jeffreys are divided into two groups :

1. Force coming through the cooling of the earth : The earth, after being formed, started cooling due to loss of heat through radiation. This process resulted in the gradual decrease of the size of the earth due to contraction on cooling. The resultant contraction provided adequate force (as believed by Jeffreys) to form various relief features including mountains.

2. Force coming through the decrease in the speed of earth's rotation : About 1,600 million years ago, the earth completed its one rotation in about 0.84 hour, whereas it presently completes one rotation in about 24 hours. The decrease in the rotational speed caused contraction in the equatorial circumference of the earth.

Mechanism of the Theory

Jeffrey's theory is based essentially on the history of the contraction of the earth. According to Jeffreys, the earth began to shrink because of contraction caused by gradual cooling of the earth due to loss of heat through radiation from the very beginning of its origin. He has mathematically calculated the extent of contraction on cooling.

A decrease of temperature up to 400°C in the 400 km thick outer shell of the earth would cause shortening of the diameter of the earth by 20 km and the circumference by 130 km due to cooling and resultant contraction.

He calculated the maximum shortening of the crust due to contraction to be 200 km and the reduction in surface area up to 5×10^6 cm^2.

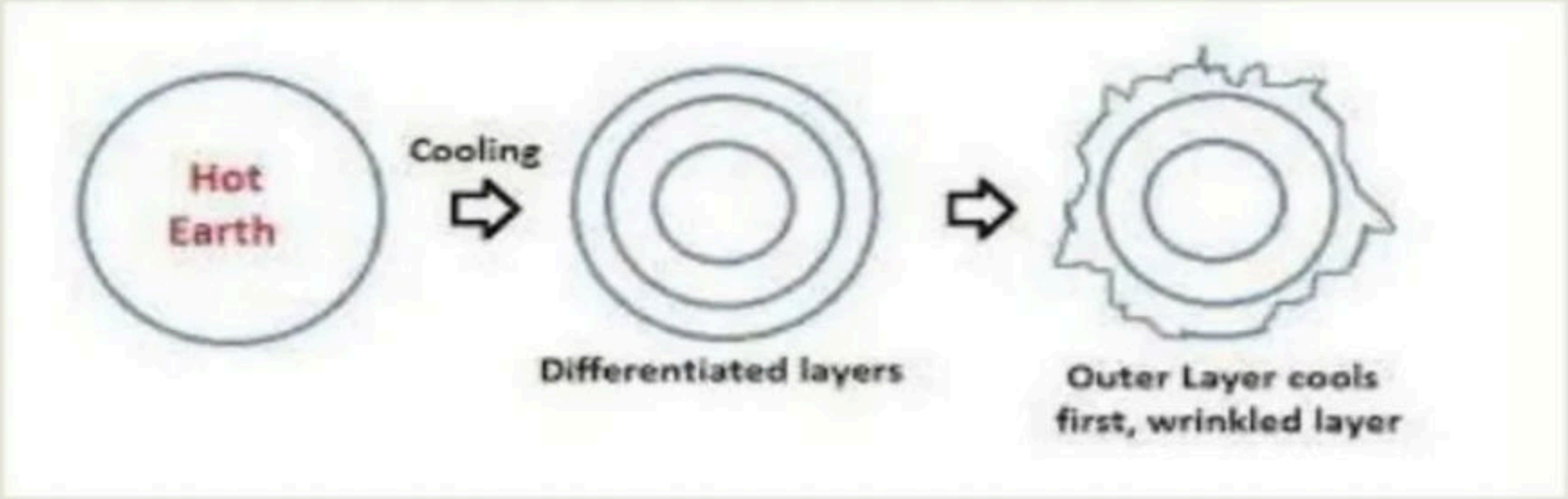
According to Jeffreys, the earth is composed of several concentric shells (layers). The cooling and resultant contraction take place layer after layer but the **cooling is effective up to the depth of only 700 km** from the earth's surface.

Within the zone of 700 km from the earth's surface, every upper layer has cooled earlier and more than the layer immediately below it.

Further, each upper layer continued to cool unless obstructed by the immediate lower layer. The outer layer began to cool first due to loss of heat through radiation.

It may be pointed out that there is a limit of cooling beyond which no further cooling is possible.

SHORTNING OF EARTH AND LEVEL OF NO STRAIN



After maximum cooling and resultant contraction of the upper layer, lower layer just lying below the upper layer begins to cool and contract, with the result already cooled and contracted upper layer becomes difficult to fit in with the still cooling and contracting lower layer.

The core of the earth is not affected by cooling because of exceptionally high temperature prevailing there.

Thus, the core obstructs the contraction of the layer lying above it. The cooling and contracting layer lying below the already cooled and contracted upper layer becomes too short to fit in with the core of the earth.

Now, there is a layer between the upper and lower layer where contraction is such that the intermediate layer can fit in with the lower layer. This layer is called **level of no strain**.

The layer lying over the level of no strain is too big to fit with the lower layer and hence the upper layer has to collapse on the lower layer so that it can fit with the lower layer. This process (collapse of upper layer on lower layer) results in the decrease in the radius of the earth which causes horizontal compressive stress which leads to buckling and folding of the rocks of upper layer. Thus, the mountains are formed.

The lower layer below the level of no strain is too short to fit with the core of the earth and hence the lower layer has to stretch horizontally.

This process implies a lateral spreading and thinning out of the materials of the lower layer below the level of no strain. The spreading and thinning of the lower layer introduces a state of stress which causes fractures and fissures resulting into breaking of rocks. This mechanism allows further collapse of the already cooled outer layer and thus already formed mountains are subjected to further rise in height.

Jeffreys has also explained various aspects of mountain building e.g., period of mountain building, zones of mountain building, direction of mountains etc.

Period of Mountain Building

According to Jeffreys, the process of aforesaid mechanism of mountain building is not always active throughout the geological periods rather is **confined to certain periods only**.

There is a continuous accumulation of compressive and tensile forces resulting from contraction of the earth due to cooling and this process continues until the accumulated forces exceed the rock strength.

When this state (when accumulated compressive and tensile forces exceed the rock strength) is reached, folding and faulting are introduced and the process of mountain building sets in and this process continues till the compressive and tensile forces are strong and active.

When these forces become weak, mountain building stops and the period of quiescence (dormancy) sets in.

Again, the process of accumulation of compressive and tensile forces starts and the next process of mountain building begins when these forces again become strong enough to fold the crustal rocks. **Thus, two periods of mountain building are separated by a long period of quiescence**.

Zones of Mountain Building

According to Jeffreys, mountain building depends upon the nature and strength of rocks.

The areas having soft & elastic rocks are most affected by the process of mountain building as the rocks are easily folded by compressive forces caused by contraction.

The regions having hard & less elastic rocks are affected by tensile forces (when being stretched) & thus several faults & fractures are formed because such rocks are easily broken into blocks.

It is, thus, apparent that mountain building is localized in certain zones of the globe.

Direction of Force

According to Jeffreys, not all the areas below the earth surface are equally affected by mechanism of cooling & contraction. The cooling process was more active below the Oceanic Crust than the Continental Crust because of dissimilar structure of these two zones.

Thus, the rocks below the Oceanic Crust experienced more cooling and contraction than the rocks below the Continental Crust.

Thus, the force of contraction is directed from Oceanic Crust towards the Continental Crust.

This mechanism results in the formation of mountains along the continental margins parallel to the oceans.

Rockies and Andes are the examples of such situation.

Direction of Mountains

According to Jeffreys, the compressive force generated by contraction of the earth due to cooling was directed from oceanic areas towards the continental areas almost **at right angle** and thus the mountain ranges were formed parallel to the oceanic areas.

The layout and direction of the Rockies and Andes mountains are very well explained on the basis of this theory because these mountains run north to south along the western margins of North and South America respectively and are parallel to the Pacific Ocean.
But the west-east extent of the Alps and the Himalayas cannot be explained on the basis of this theory.

Evaluation of the Thermal Contraction Theory

Though Jeffreys has attempted to explain the origin and evolution of surface features of the earth and has presented several evidences in support of his thermal contraction theory but his theory has been **severely criticised and attacked** on the **following grounds** :

1. The force of contraction resulting from cooling of earth is not sufficient enough to account for the origin & evolution of major surface reliefs of the globe. A. Holmes has remarked that *"the calculated reduction of area (by Jeffreys) is seriously in deficit of the amount to explain mountain building."*

2. The concept of cooling of the earth in the system of concentric shells (layers) is erroneous and is not acceptable.

3. The impact of decrease in the speed of rotation of the earth on mountain building is doubtful. J.A. Steers (1932) has aptly remarked, *"It may, in fact, be safely concluded that whatever effects the changing speed of rotation in geological times may have had, it was totally inadequate to influence mountain building in any marked way."*

4. It is improper to believe that contraction would have been so immense about 200 million years ago so that it might have formed such gigantic mountains of Tertiary period as the Rockies, the Andes, the Alps, the Himalayas etc.

5. As per thermal contraction theory of Jeffreys, the continents and oceans should have been uniformly distributed as the earth was contracted from all sides but presently there is uneven distribution of continents and oceans.

6. According to this theory, the situation of mountains should always be parallel to the oceans. The arrangement of the Rockies and Andes is justified on the basis of this theory but the arrangement of European Alpine mountains and the Himalayas cannot be explained.

7. If we believe in the competence of the force of contraction to form mountains, it cannot produce great ranges of mountains as they are found at present over the globe but it would produce a larger number of small puckers or minor folds.

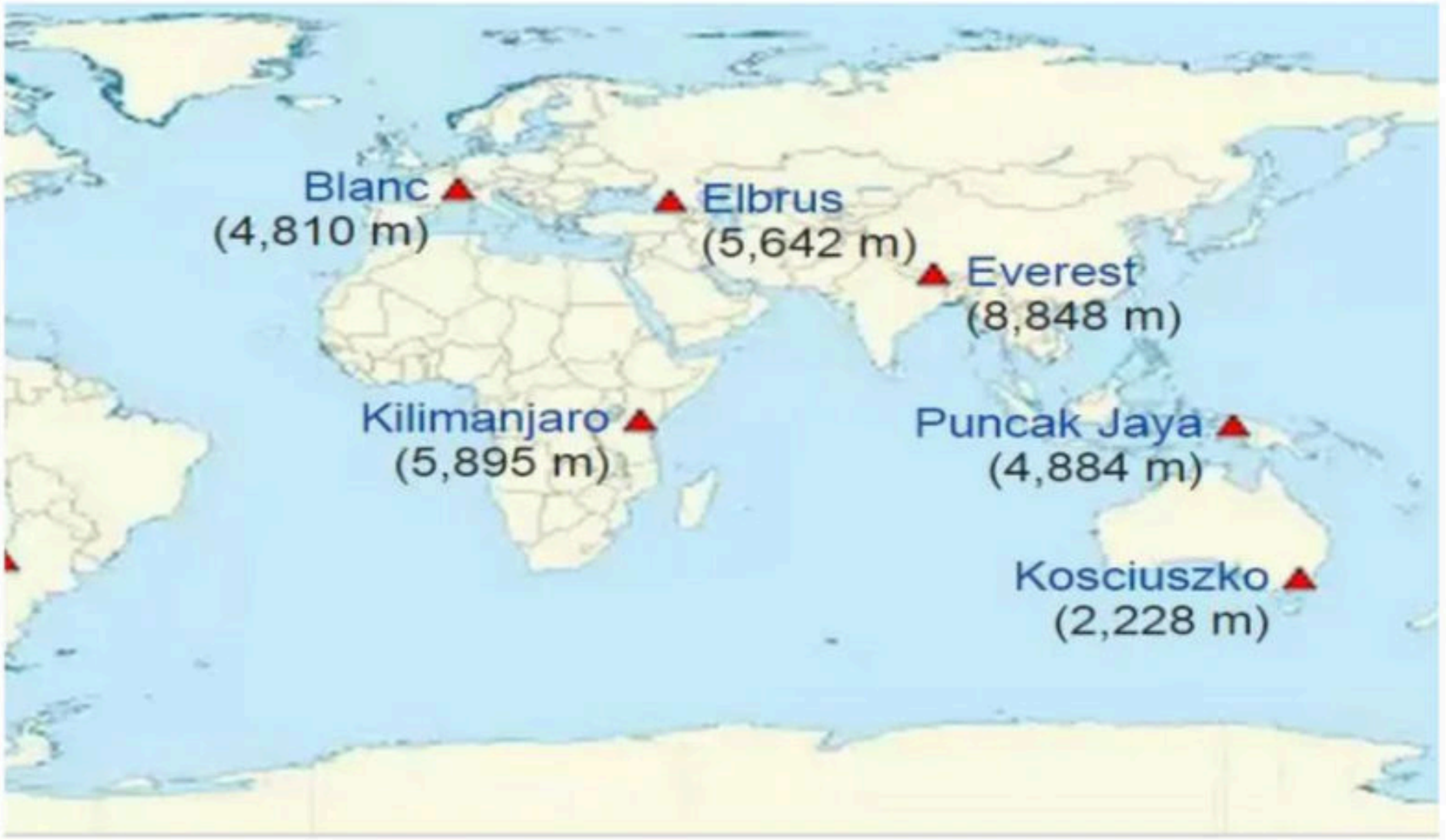
8. According to this theory, there should not be any definitive distributional pattern of mountains as they may be formed everywhere because all parts of earth's crust experienced contraction but contrary to this mountains are found in certain patterns e.g., along the margins of the consents extending either north-southward or west-eastward.

9. It has been argued that on the thermal contraction theory the time interval between various mountain buildings should have increased as cooling progressed, but in fact, judged on other evidence, the interval seems to have remained almost about the same.

10. Jeffreys' earlier quantitative estimates of contraction due to cooling have been outright rejected because the effect of radioactivity has been totally neglected. In Holmes' opinion, to ignore the heat produced by radioactive disintegration would be as wrong as to ignore the effect of gravitation.

11. Lastly, but not the least, is the presence of fossils in the rocks of the folded mountains. It clearly indicates the birth of folded mountains in seas, a fact which invalidates the thermal contraction theory of the mountain building.

TYPES OF MOUNTAINS & OROGENY



by Tarun Goyal


WORLD
Physical
ARCTIC OCEAN
Queen Elizabeth Islands
Baffin Bay
Chukchi Sea
Beaufort Sea
Brooks Range
Bering Sea
Gulf of Alaska
Aleutian Islands
Rocky Mountains
NORTH AMERICA
Hudson Bay
Labrador Sea
Laurentian Plateau
Great Lakes
Appalachian Mts.
NORTH PACIFIC OCEAN
Sierra Madre Occidental
Gulf of Mexico
Sargasso Sea
NORTH ATLANTIC OCEAN
Caribbean Sea
Isthmus of Panama
Guyana Basin
Amazon Basin
SOUTH AMERICA
Brazilian Highlands
Peru Basin
Chile Basin
Andes
Pampas
Patagonia
SOUTH PACIFIC OCEAN
Argentine Basin
Strait of Magellan
Cape Horn
SOUTH ATLANTIC OCEAN
Atlantic-Indian-Antarctic Basin
Barents Sea
Kara Sea
Laptev Sea
Norwegian Sea
Scandinavia
North European Plain
Ural Mountains
Siberian Plateau
East Siberian Sea
Chukchi Sea
Kolyma Range
Bering Sea
Sea of Okhotsk
North Sea
Baltic Sea
EUROPE
West Siberian Plain
Lake Baikal
ASIA
Celtic Sea
Bay of Biscay
Alps
Iberian Peninsula
Aral Sea
Gobi Desert
Tien Shan
Black Sea
Caspian Sea
Anatolia
Atlas Mtns
Mediterranean Sea
Sea of Japan (East Sea)
Plateau of Tibet
Himalaya
Mt. Everest 8848 m
Northwest Pacific Basin
Sahara Desert
Arabian Peninsula
Red Sea
Deccan Plateau
Bay of Bengal
Arabian Sea
Indo-China Peninsula
Phillipine Sea
Lake Chad
AFRICA
Congo Basin
Ethiopian Highlands
Great Rift Valley
Gulf of Guinea
Lake Victoria
INDIAN OCEAN
Micronesia
PACIFIC OCEAN
Greater Sunda Islands
Mid Indian Basin
Angola Basin
Kalahari Desert
Drakensberg
West Australian Basin
Great Sandy Desert
AUSTRALIA
Nullarbor Plain
Great Dividing Range
Coral Sea
Melanesia
Cape of Good Hope
South Australian Basin
Tasman Sea
Southern Alps
HEIGHT (in Metres)
4000
2000
1000
500
200
0 (Sea Level)

Orogeny

- It is a process in which a section of the earth's crust is folded and deformed by lateral compression to form a mountain range.
- Orogenic movements are 'Tectonic movements' of the earth which involve the folding of sediments, faulting and metamorphism.

Classification on the Basis of Location

Coastal Mountains : Rockies, Appalachians, Alpine, Atlas, etc.

Inland Mountains : Vosges and the Black Forest (Europe), Kunlun, Tien Shan, Altai mountains of Asia, Urals of Russia, Aravallis, Himalayas, Satpura, Maikal of India, etc.

Oceanic Mountains

- Oceanic mountains are found on continental shelves and ocean floors.
- If the height of the mountains is considered from the ocean floor, **Mauna Kea (10,200)** would be the highest mountain.

4.5 b.4.

1. Pre-Cambrian Mt.
2. Caledonian Mt.
3. Hercynian Mtn.
4. Alpine Mtns.

→ loftiest

→ edges sharp

ON THE BASIS OF PERIOD OF ORIGIN

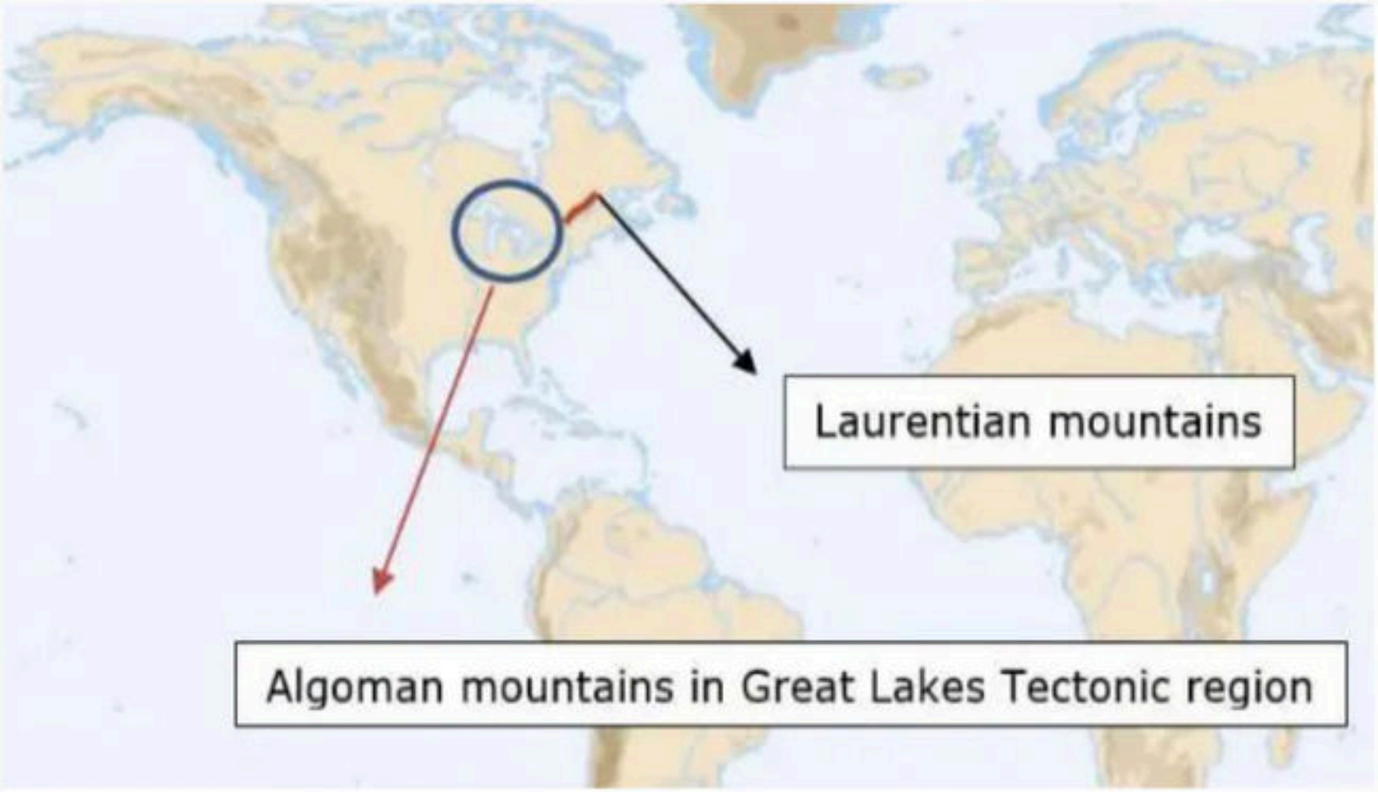
- Many orogenic or mountain-building movements have taken place so far.
- Some of them occurred in Pre-Cambrian times (between 600-3,500 m.y.a.). The three more recent orogenies are the Caledonian, Hercynian and Alpine.

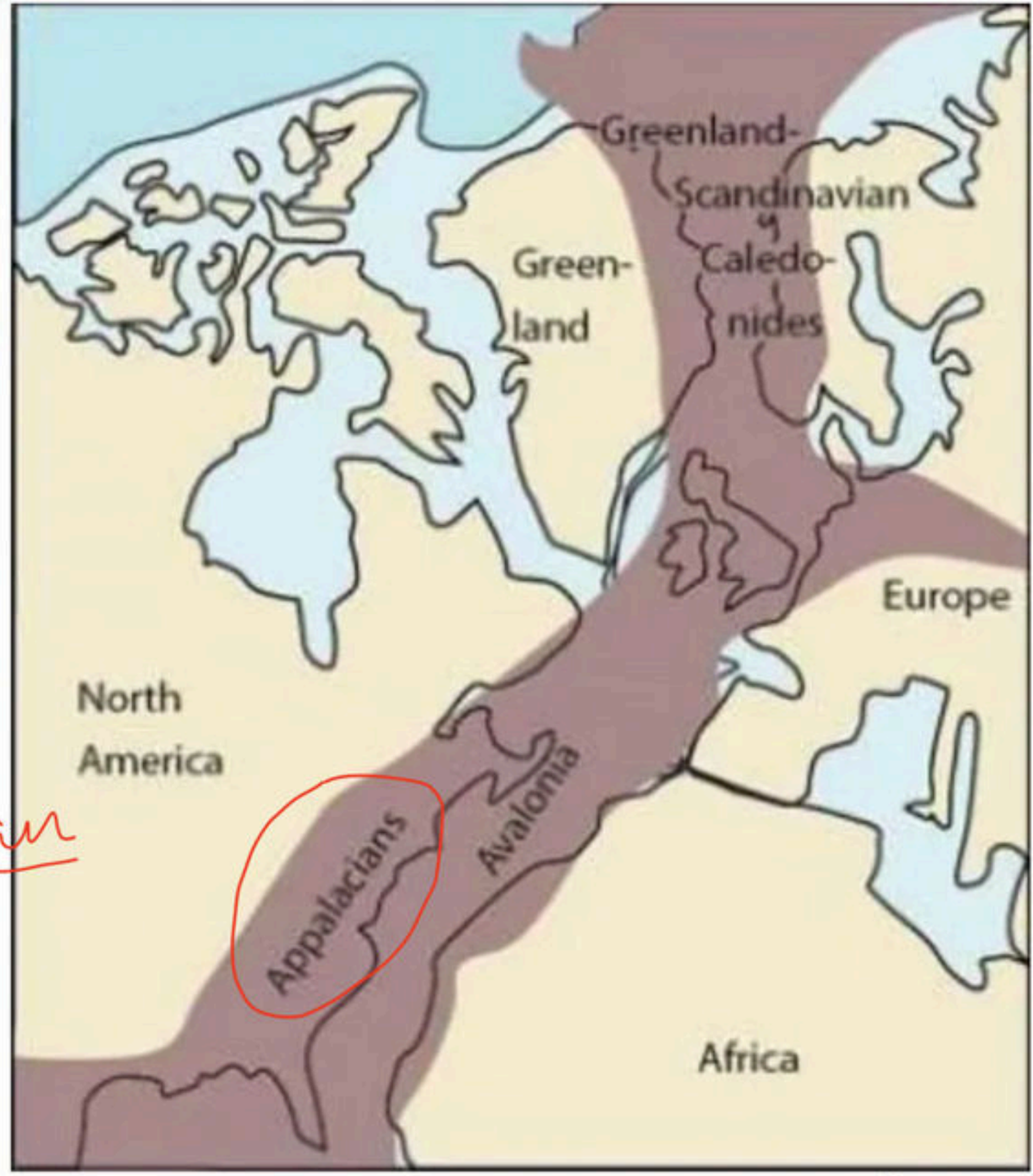
1. Pre-Cambrian Mountains

- Belong to the Pre-Cambrian period, a period that extended for more than 4 billion years.
- The rocks have been subjected to upheaval, denudation & metamorphosis. So the remnants appear as **'Residual Mountains'**.
- Some of the examples are Laurentian mountains & Algoman mountains.

2. Caledonian Mountains

- It was caused by the closure of the Iapetus Ocean when the continents and terrains of Laurentia, Baltica and Avalonia collided in the period from the start of the Cambrian (542 m.y.a.) to the end of the Silurian (about 416 m.y.a.).
- The final collision was between a N.W. European and a North American–Greenland continent, and it gave rise to prominent mountain ranges.
- Examples are the **Appalachians**, Scandinavian Mountains, Svalbard, Eastern Greenland, parts of north-central Europe and **Aravallis**.
- The Caledonian orogeny is named for Caledonia, the Latin name for Scotland.





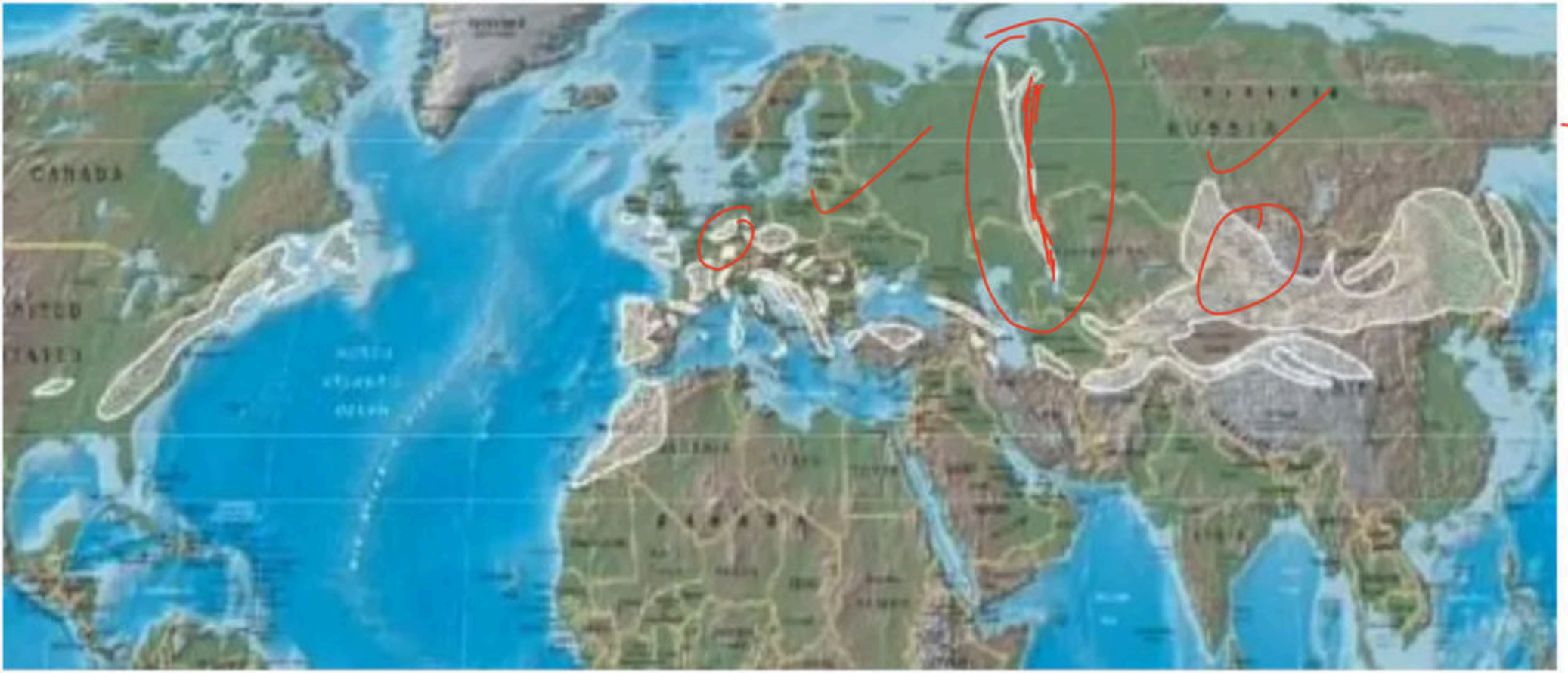
Aravallis

Iapetus Ocean

370 m.y.

3. Hercynian Mountains

- These mountains originated during the upper Carboniferous to Permian Period.
- They came into existence between approx. **340 million years and 225 million** years ago.
- Some examples are the mountains of **Vosges and Black Forest** of Europe, **Altai, Tian Shan mountains** of Asia, **Ural Mountains**, etc.



→ Block Mts

Fig : Caledonian and Hercynian mountains

4. Alpine System

- Has its origin in the Tertiary Period (66 m.y.a. - 2.6 m.y.a.) which consists of the Palaeocene, Eocene, Oligocene, Miocene and Pliocene epochs.
- The mountains were formed from about 65 million years to 7 million years ago. Examples are :
  - **Rockies** of North America,
  - **Alpine** mountains of Europe
  - **Atlas** mountains of north-western Africa
  - **Himalayas** of the Indian subcontinent radiating from Pamir knot.

Being the most recently formed, these ranges, such as the Alps, Himalayas, Andes and Rockies are the loftiest with rugged terrain.

ON THE BASIS OF MODE OF ORIGIN

Original or Tectonic mountains

- Original or Tectonic mountains are the product of tectonic forces.
- The tectonic mountains may be categorized into
  - ***Fold Mountains*** (Himalayas, Rockies, Andes etc.),
  - ***Block Mountains*** (Vosges mountains in France, Black Forest in Germany, Vindhya and Satpura in India etc.) and
  - ***Volcanic Mountains*** (Cascade Range in USA, Mt Kenya, Mt Kilimanjaro, Mt Fujiyama etc.).

Circum-erosional / Relict / Residual Mountains

- Aravallis in India, Urals in Russia, etc. are the remnants of old fold mountains derived as a result of **denudation**.

1. Fold Mountains

- They are formed when the rocks of the crust of the earth fold under stress, mainly by forces of compression (as a result of series of earthquakes).
- They are formed when sedimentary rock strata in **geosynclines** are subjected to compressive forces.
- The presence of fossils suggests that the sedimentary rocks of these folded mountains were formed after accumulation and consolidation of silt and sediments in a marine environment.
- They are the loftiest mountains and are generally concentrated along continental margins facing oceans.
- Recurrent seismicity is a common feature in folded mountain belts.
- They extend for great lengths whereas their width is considerably small.

Fold mountains can be divided into two broad types on the basis of the nature of folds :

1. Simple Fold Mountains

- With open folds, in which well-developed systems of synclines and anticlines are found & folds are of wavy patterns. E.g., Jura mountains.

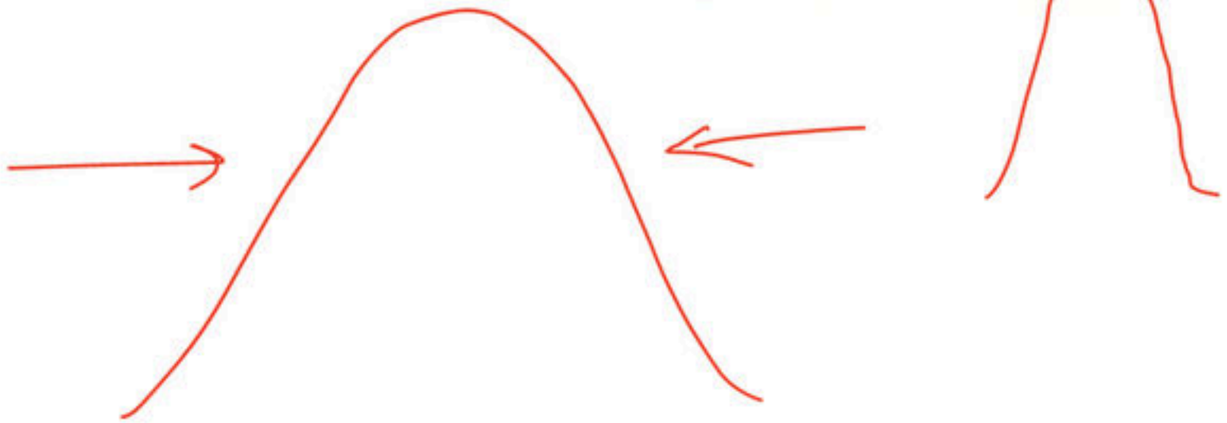


2. Complex Fold Mountains

- In which the rock strata are intensely compressed to produce a complex structure of folds.
- In the Himalayas, over folds and recumbent folds are often found detached from their roots and carried few hundred km. away by the tectonic forces. These detached folds are called ***nappe***.

On the basis of **period of origin**, fold mountains are divided into very old fold mountains, old fold mountains and Alpine fold mountains.

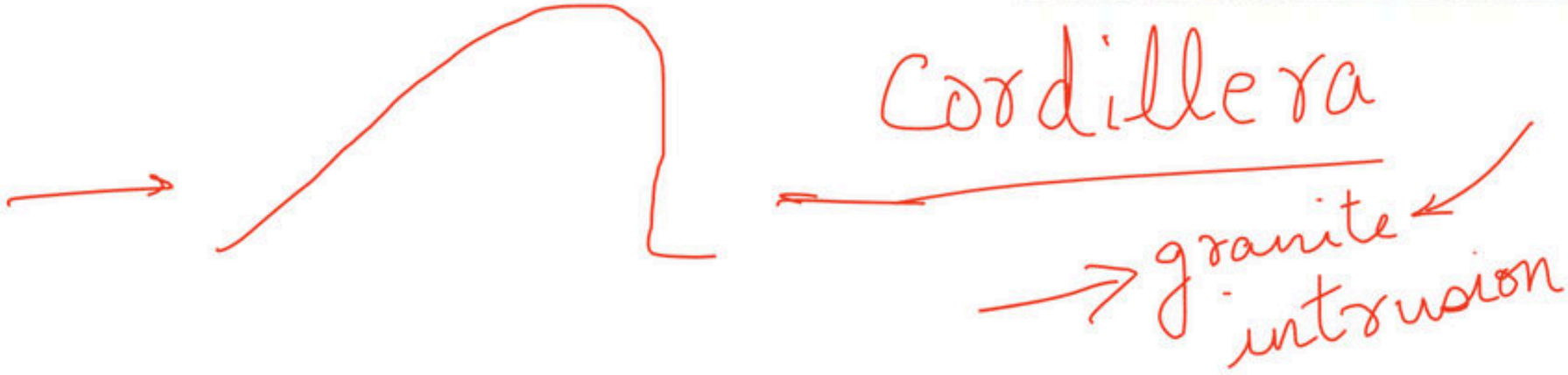
1. Very Old Fold Mountains



- They are more than 500 million years old.
- Rounded features (due to denudation).
- Low elevation.
- The **Appalachians** in North America and the **Ural mountains** in Russia.






Cordillera
granite intrusion

2. Old Fold Mountains

- Old fold mountains had their origin before the Tertiary period (70 million years).
- The fold mountain systems belonging to Caledonian and Hercynian mountain-building periods fall in this category.
- They are also called as Thickening relict fold mountains because of lightly rounded features and medium elevation.
- Top layers worn out due to erosional activity.
- Example: Aravalli Range (oldest fold mountain systems in India; formed approx. 370 m.y.a.).
- Aravalli Range has considerably worn-down due to the processes of erosion. The range rose in post-Precambrian event called the Aravalli-Delhi orogeny (Silurian and early Devonian periods).

3. Alpine or Young Fold Mountains

- Alpine fold mountains belonging to the Tertiary period can be grouped under the new fold mountains category.
- Examples are **Rockies, Andes, Alps, Himalayas**, etc.

Characteristics

- Rugged relief; Imposing height (lofty); High Conical Peaks.

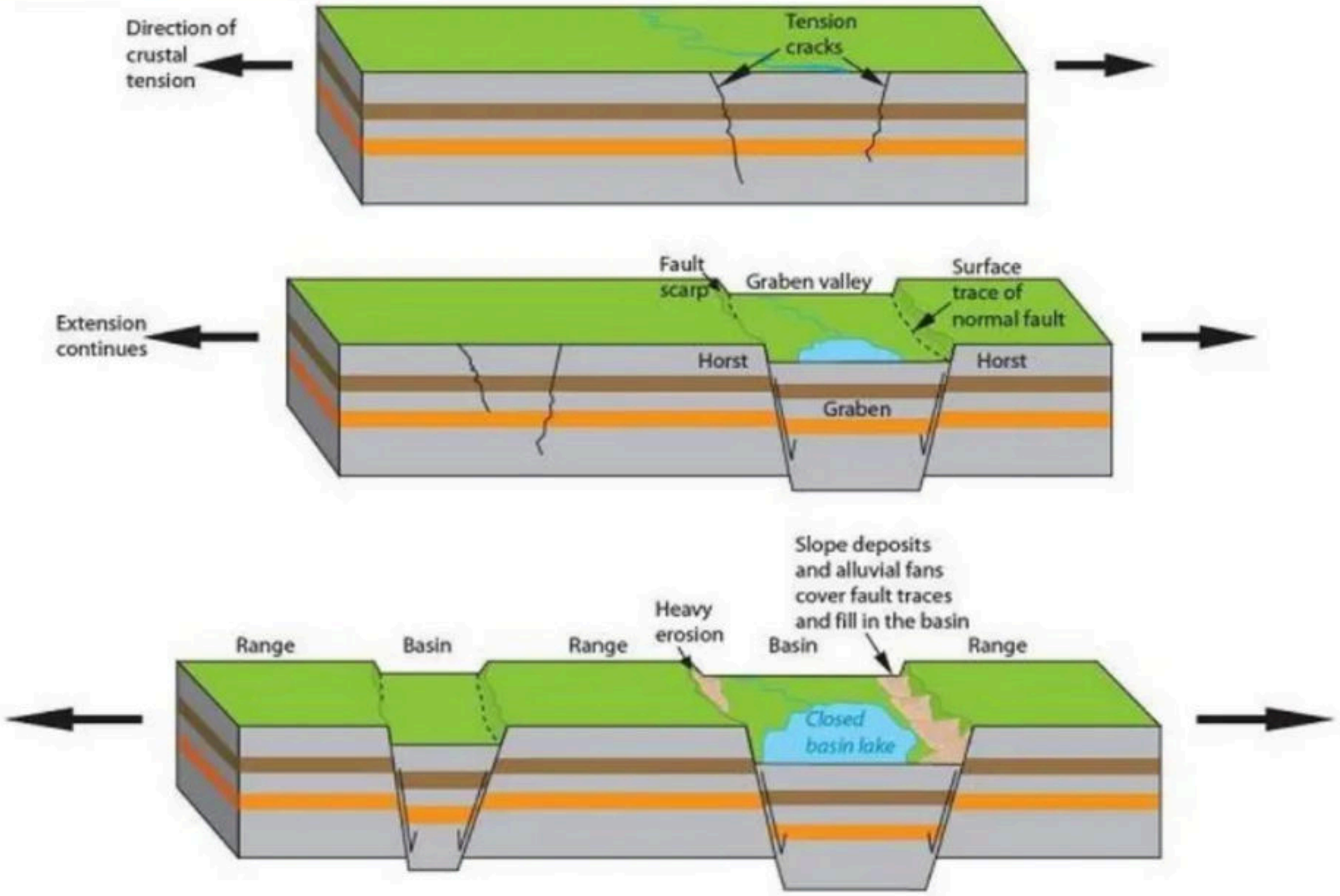
Characteristics of Fold Mountains

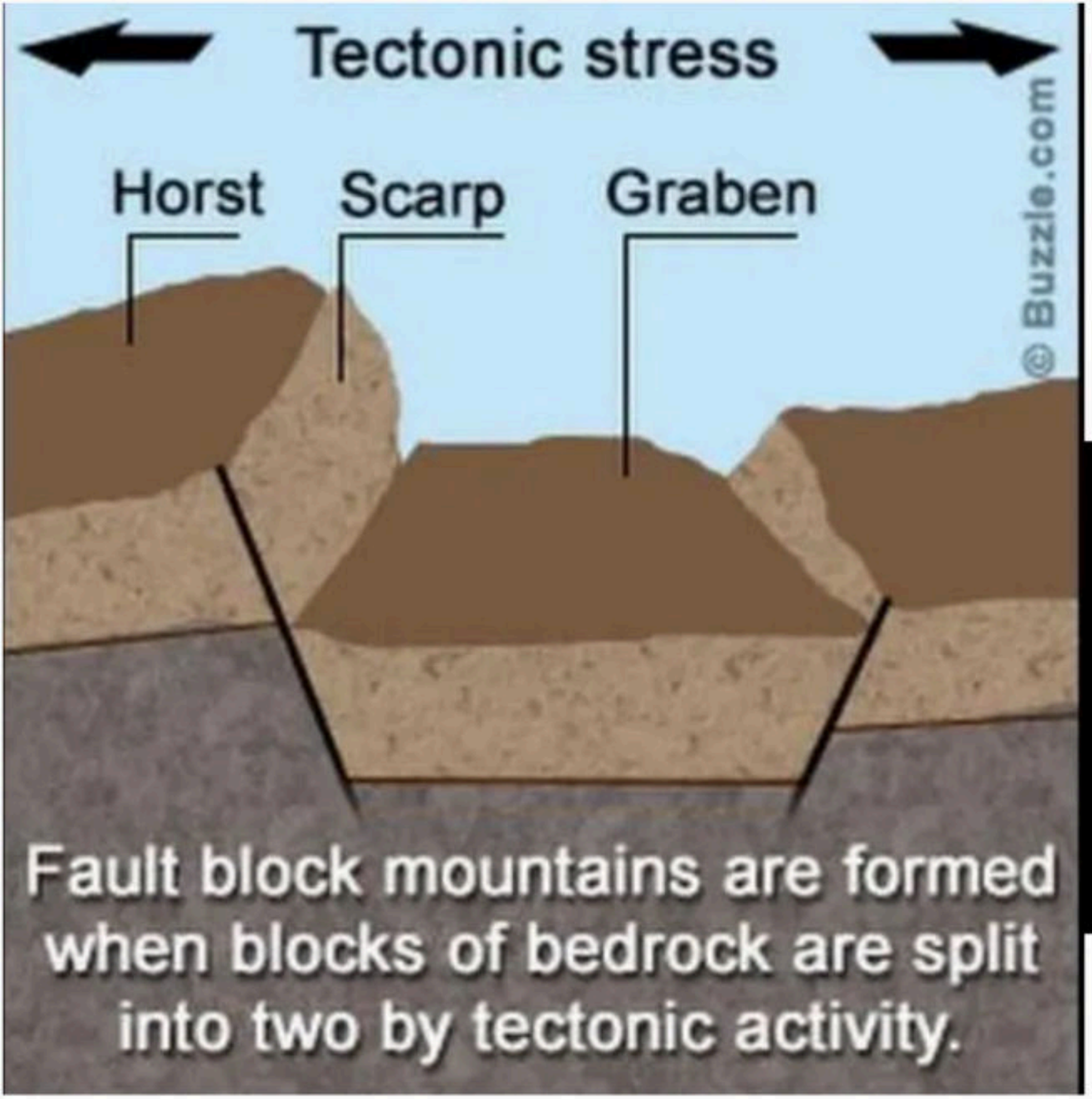
- Fold mountains belong to the group of youngest mountains of the earth.
- The presence of fossils suggests that the sedimentary rocks of these folded mountains were formed after accumulation and consolidation of silts and sediments in a marine environment.
- Generally, fold mountains have a steep slope on one side and a gentle slope on the other.
- Fold mountains are characterized by granite intrusions on a massive scale.
- High heat flow often finds expression in volcanic activity (though not exactly in Himalayas).
- These mountains are by far the most widespread and also the most important.
- They also contain rich mineral resources such as tin, copper, gold.

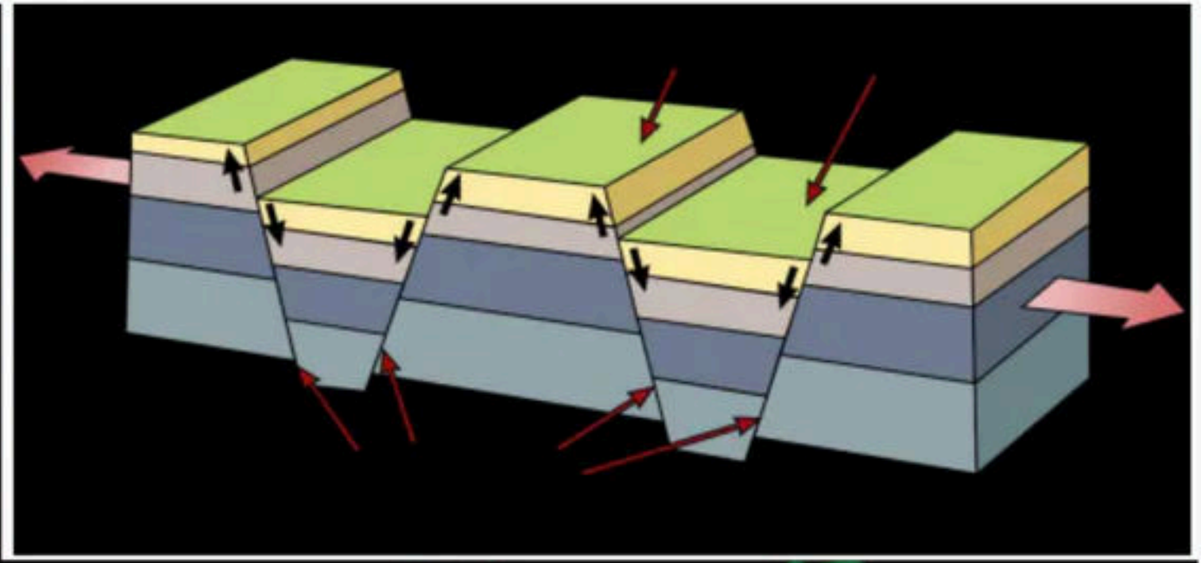
2. Block Mountains

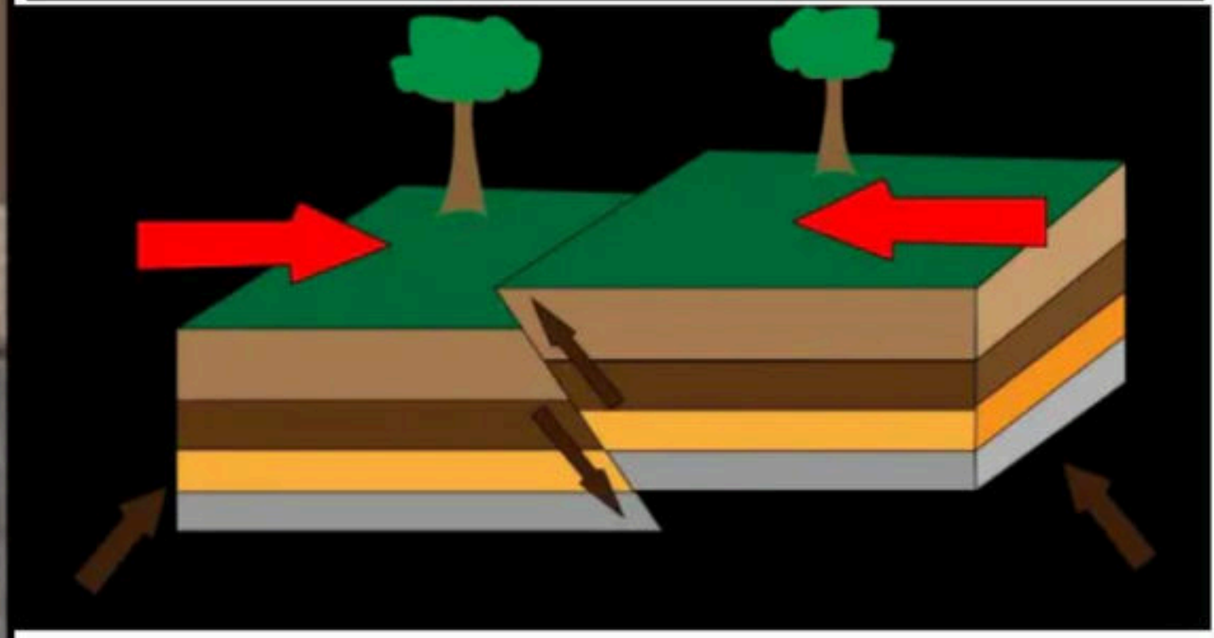
- They are created when large areas or blocks of earth are broken and displaced vertically.
- When the earth's crust bends, folding occurs, but when it cracks, faulting occurs. That's why they are also called fault block mountains as they're formed due to faulting as a result of tensile and compressive forces.
- The faulted edges are very steep, e.g. the Vosges and Black Forest of the Rhineland.
- Tension may also cause the central portion to be let down between two adjacent fault blocks forming a rift valley, which will have steep walls.
- The uplifted blocks are termed as **horsts** and the lowered blocks are called **graben**.
- Great African Rift Valley, Rhine Valley & Vosges mountain in Europe are the examples.
- The East African Rift (EAR) Valley system is the best example, where the African Plate is in the process of splitting into two tectonic plates, called the Somali Plate and the Nubian Plate, at a rate of 6 to 7 mm per year. It is 6,000 km long, stretching from the Beqaa Valley in Lebanon in Asia to Mozambique in S.E. Africa.
- Compressional forces set up by earth movements may produce a thrust or reverse fault & shorten the crust. A block may be raised or lowered in relation to surrounding areas.

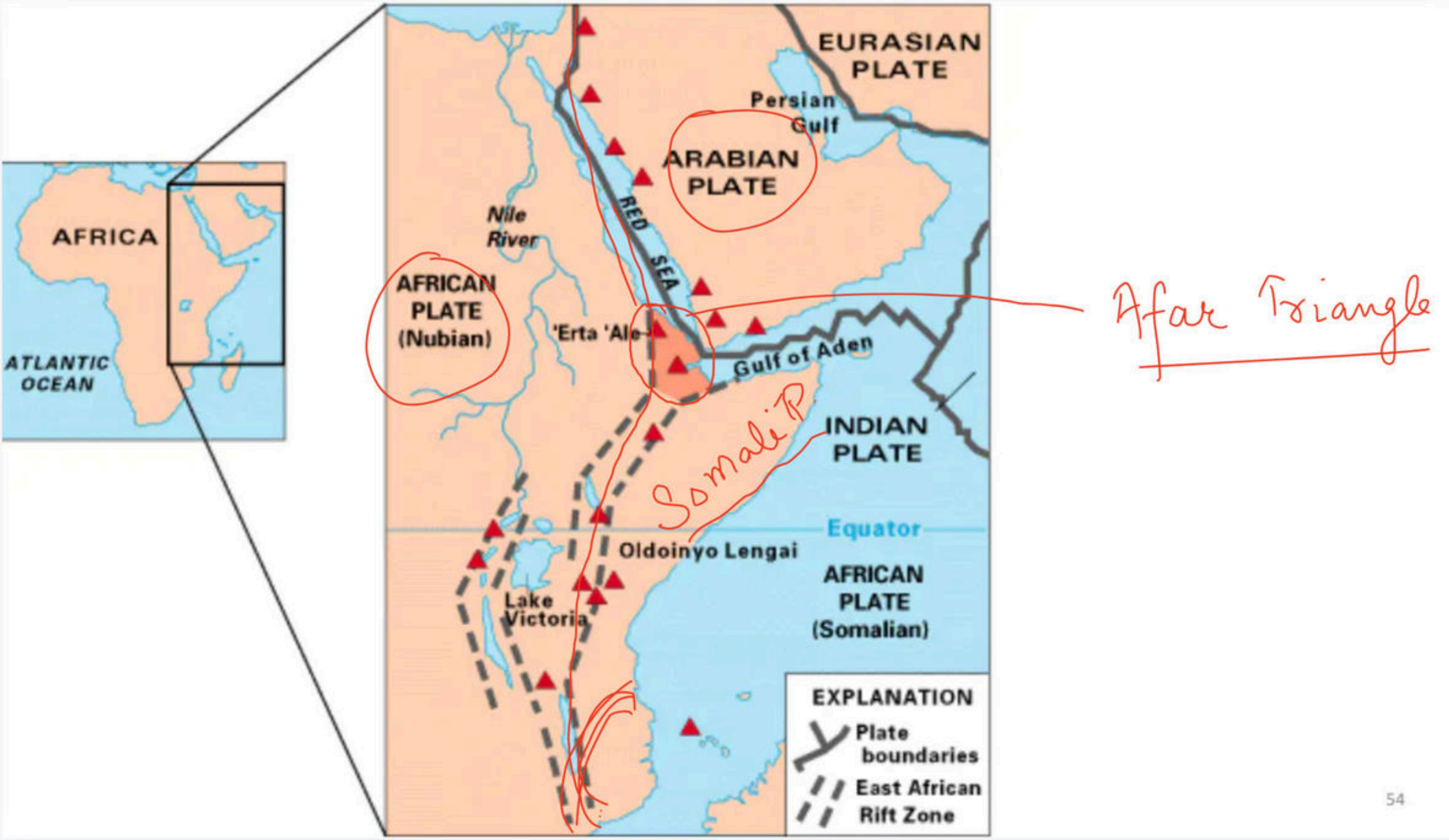
Horst and Graben




Tectonic stress
Horst
Scarp
Graben
© Buzzle.com
Fault block mountains are formed when blocks of bedrock are split into two by tectonic activity.






AFRICA
ATLANTIC OCEAN
EURASIAN PLATE
Persian Gulf
ARABIAN PLATE
RED SEA
Nile River
AFRICAN PLATE (Nubian)
'Erta 'Ale
Gulf of Aden
Somali P.
INDIAN PLATE
Equator
Oldoinyo Lengai
Lake Victoria
AFRICAN PLATE (Somalian)
EXPLANATION
Plate boundaries
East African Rift Zone
Afar Triangle

3. Volcanic Mountains

- Volcanic mountains are formed due to volcanic activity.
- These are, in fact, volcanoes which are built up from material ejected from fissures in the earth's crust.
- The materials include molten lava, volcanic bombs, cinders, ashes, dust and liquid mud.
- They fall around the vent in successive layers, building up a characteristic volcanic cone.
- Volcanic mountains are often called mountains of accumulation.
- Eg : Cotopaxi in Andes, Vesuvius and Etna in Italy, Fujiyama in Japan, Mauna Loa and Kilauea (Most active volcano) in Hawaii, Ojos del Salado in Argentina / Chile (Highest active volcano), Popocatépetl in Mexico, Raineer of Washington, Stromboli in Mediterranean (called Lighthouse of the Mediterranean), Mirapi and Krakatoa in Indonesia, Taal in Philippines, etc.

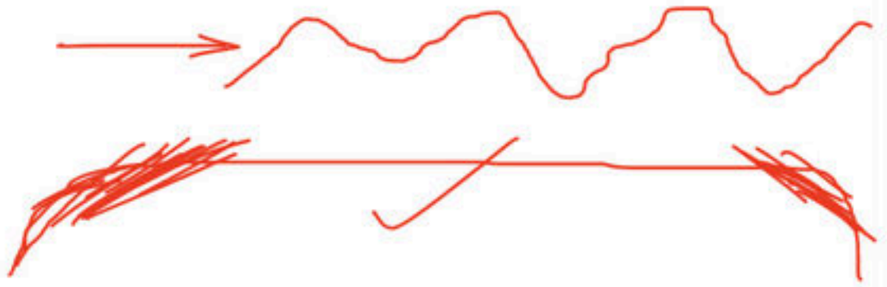
Top - 15

Active V.

4. Residual / Relict Mountains

- These are mountains evolved by **denudation**.
- Where the general level of the land has been lowered by the agents of denudation, some very resistant areas may remain and these form residual mountains, e.g. Mt. Manodnock in US.
- Residual mountains may also evolve from plateaus which have been dissected by rivers into hills and valleys.
- Examples of dissected plateau, where the down-cutting streams have eroded the uplands into mountains of denudation, are the Highlands of Scotland, Scandinavia and the Deccan Plateau.





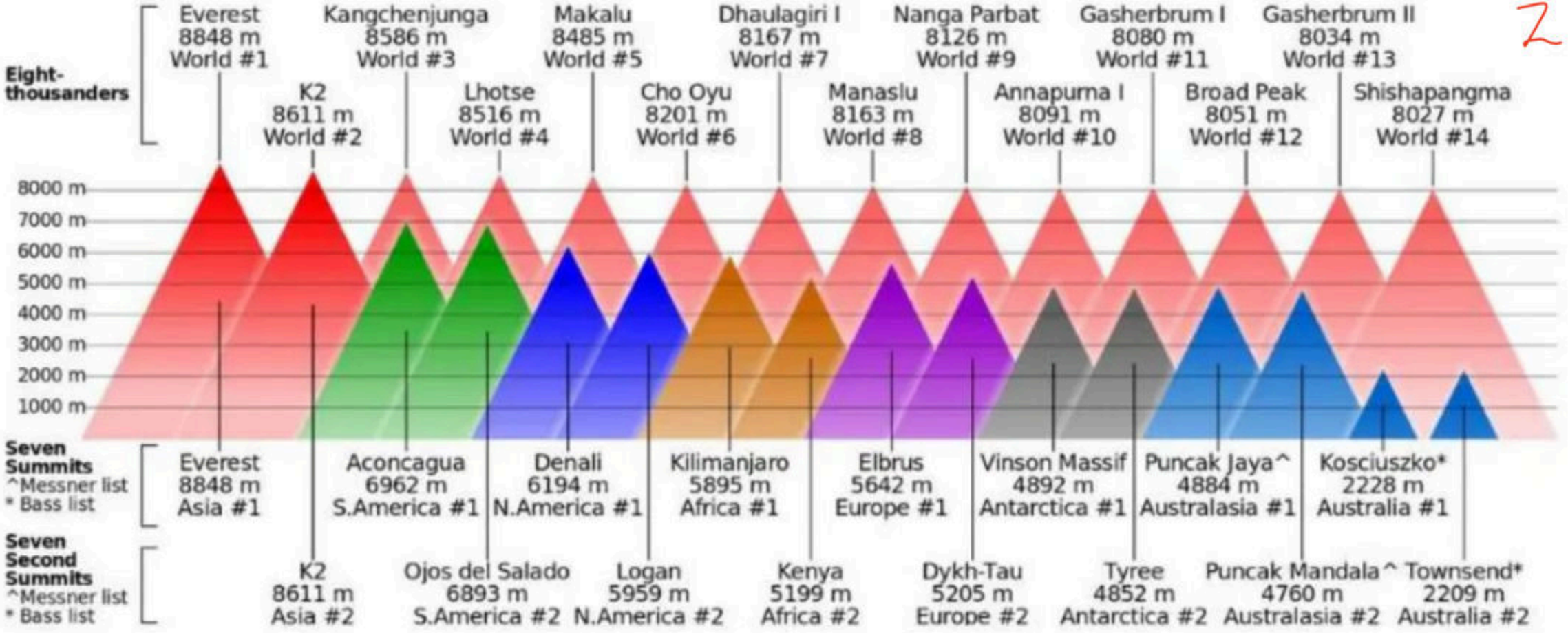
Why World's Highest Mountains are at the Equator?

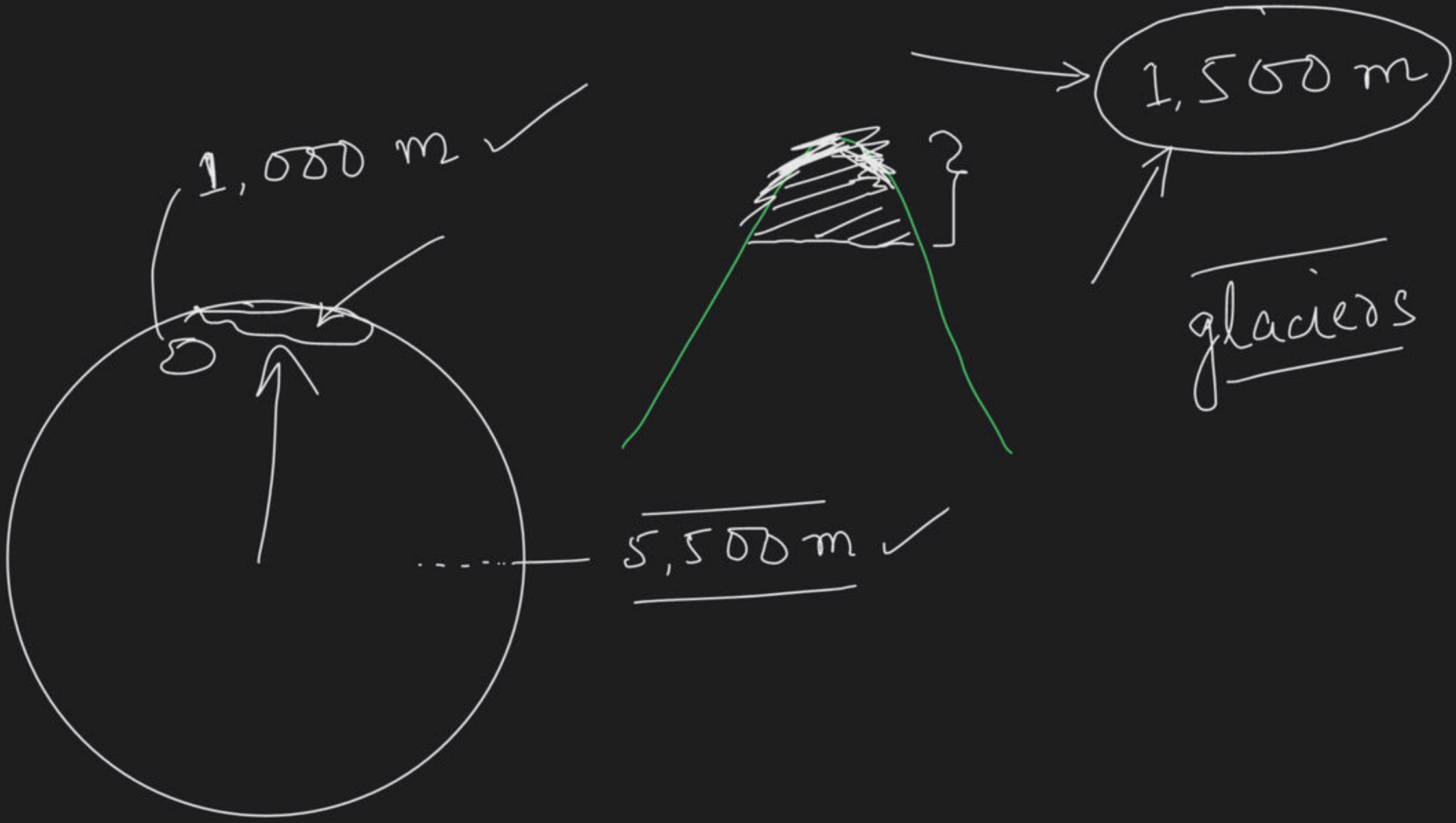
- Scientists have solved the mystery of why the world's highest mountains sit near the equator.
- **Colder climates are better at eroding peaks**. In colder climates, the snowline on mountains starts lower down, and erosion takes place at lower altitudes.
- In general, **mountains only rise to around 1,500 m above their snow lines**, so it is the altitude of these lines — which depends on climate and latitude — which ultimately decides their height.
- At low latitudes, the atmosphere is warm and the snowline is high. Around the equator, the snowline is about 5,500 m at its highest so mountains get up to 7,000 m.
- There are a few exceptions, such as Mt. Everest, but extremely few.
- When you then go to Canada or Chile, the snowline altitude is around 1,000 m, so the mountains are around 2.5 km.
- Ice and glacier coverage at lower altitudes in cold climates is more important than collision of tectonic plates.
- Glacial erosion is very strong because of huge boulders of rocks carried by the glacial ice that graze the surface. Though ice moves only few meters a day, it can take along it huge rocks that can peel the outer layers.

Highest Mountain Peaks of the World

Tropical & Sub-tropical Z.

b/w 30 - 35° N & S




1,000 m
?
1,500 m
glaciers
5,500 m

Important Mountain Ranges

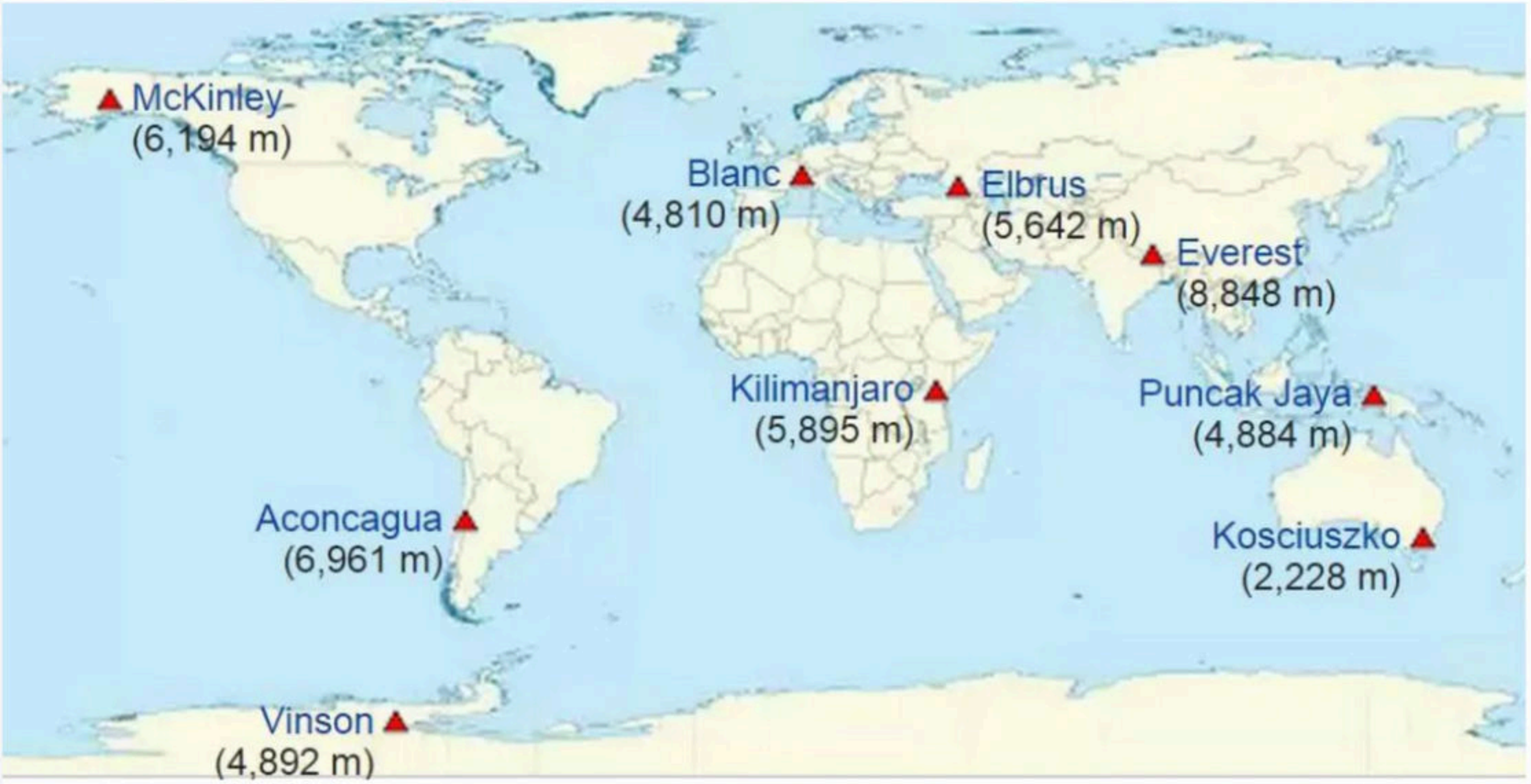
- The highest known mountain on any planet in the Solar System is **Olympus Mons** on **Mars** (~26 km in elevation). It is also the highest active volcano in the Solar System.

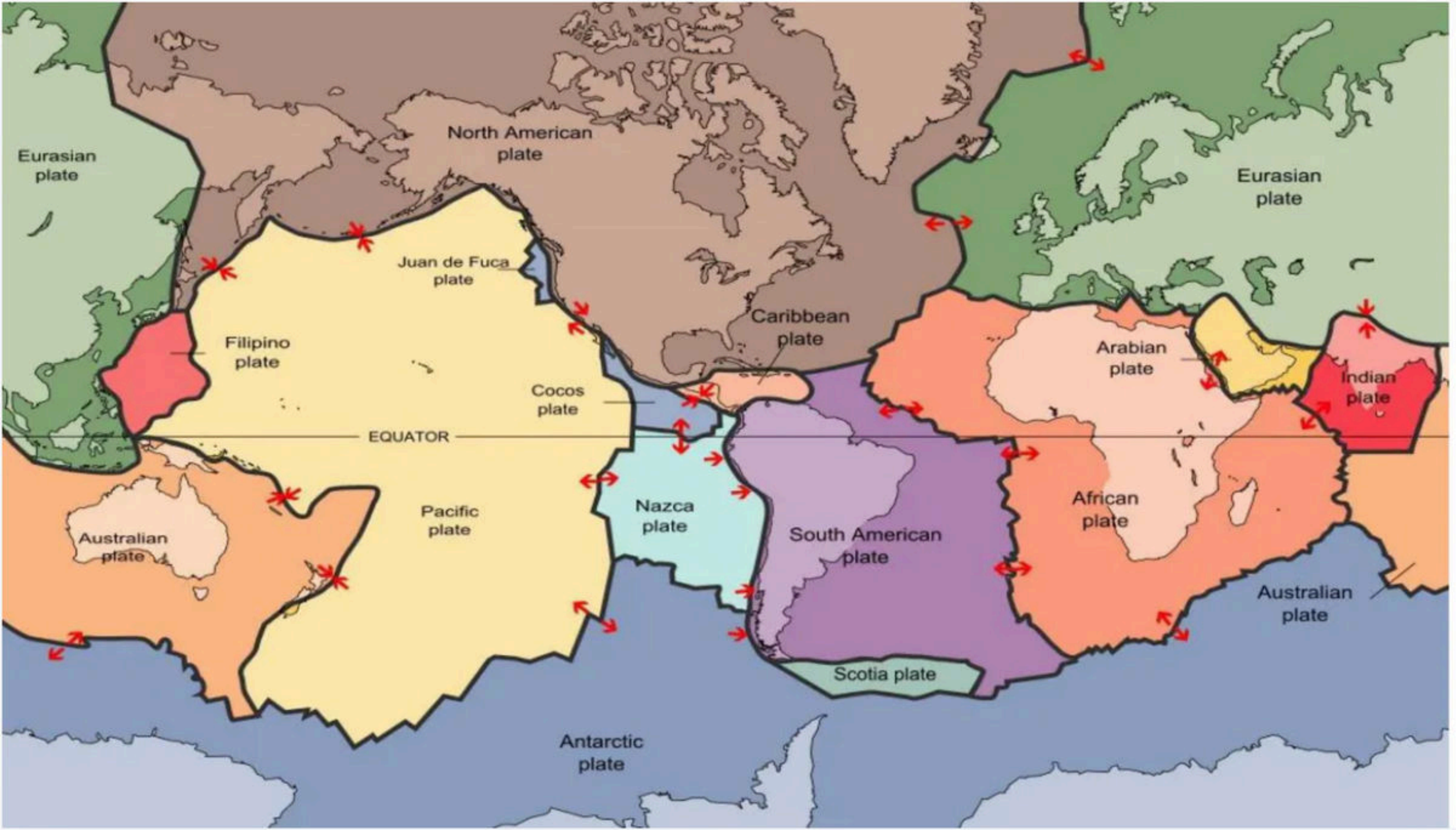
Range	Location	Highest Peak (m)
Andes (longest mountain range)	South America	6,960
Himalayas-Karakoram-Hindukush	South Central Asia	8,848
Rockies	North America	4,401
Great Dividing Range	East Australia	2,228
Caucasus	Europe, Asia	5,642
Alaska	USA	6,194
Alps	Europe	4,808
Apennines	Europe	2,912
Ural	Asia	1,895
Pennines	Europe	893
Pyrenees	Europe	3,404
Appalachian	North America	2,040

Mountain Ranges by Height

- **Himalayas** – Asia: India, China, Nepal, Pakistan, Bhutan; highest point- Everest; 8848 m.
- **Karakoram** – Asia: Pakistan, India, China; highest point- K2, 8611 m.
- **Hindu Kush** – Asia: Afghanistan, Pakistan, India; highest point- Tirich Mir (in Pakistan), 7708 m.
- **Pamir** – Asia: Tajikistan, China, Afghanistan, Pakistan, India; highest point – Ismail Samani Peak (in Tajikistan), 7495 m.
- **Tian Shan** – Asia: China, Kazakhstan, Uzbekistan, Kyrgyztan, India, Pakistan; highest point – Jengish Chokusu (Kyrgyzstan-China border), 7439 m.

Some High Peaks and Their Location




Eurasian plate
North American plate
Eurasian plate
Juan de Fuca plate
Caribbean plate
Filipino plate
Arabian plate
Indian plate
Cocos plate
EQUATOR
Pacific plate
Nazca plate
African plate
South American plate
Australian plate
Australian plate
Scotia plate
Antarctic plate

IMPORTANT MOUNTAIN RANGES

ANDES

- The Andes is the **longest** continental mountain range in the world (7,000 km long).
- Formed due to Ocean-Continent collision.
- Average height of about 4,000 m.
- Spread along Venezuela, Colombia, Ecuador, Peru, Bolivia, Chile and Argentina.
- World's highest mountain range outside Asia.
- The highest peak, **Mount Aconcagua** (6,960 m; highest in both Southern and Western Hemispheres).
- World's highest volcanoes are in the Andes. **Ojos del Salado** (means *"Eyes of the salty one"*; 6,893 m) on the **Chile-Argentina** border is the highest active volcano on earth.

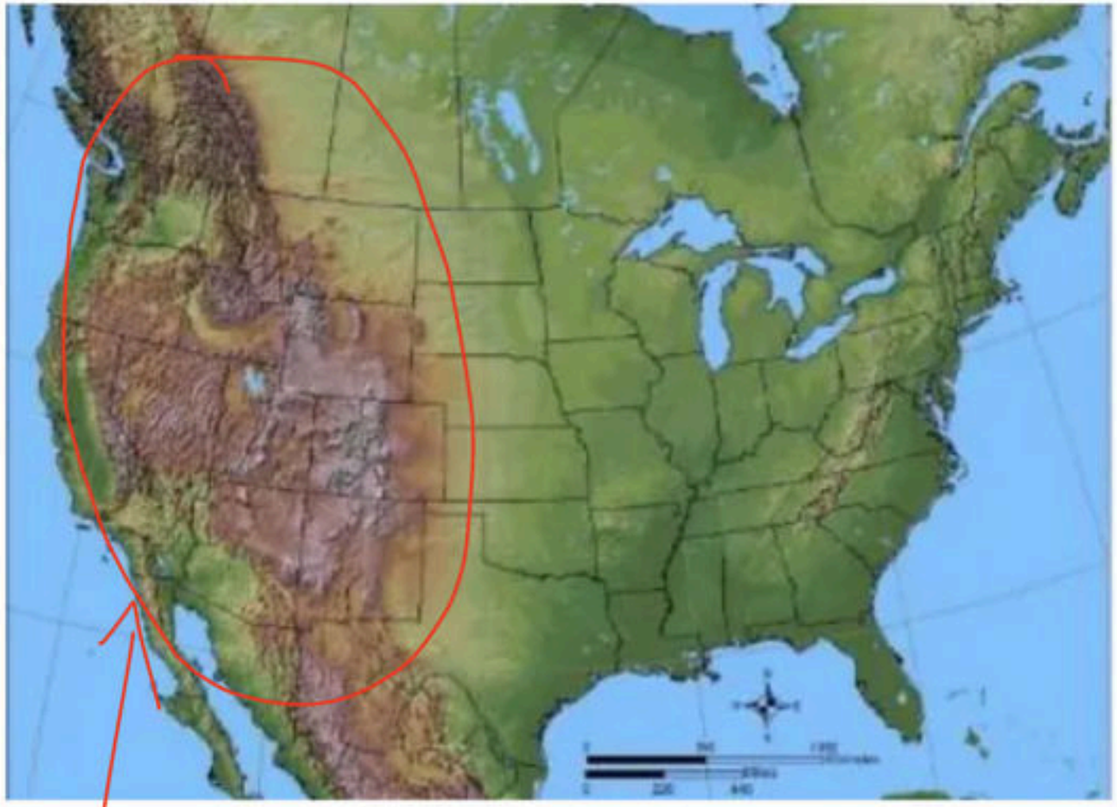
Geology

- Caused by the subduction of oceanic crust beneath the South American plate.
- Formed due to compression of western rim of the South American Plate due to the subduction of the **Nazca Plate**.



ROCKY MOUNTAINS

- Mountain range in western North America.
- The Rocky Mountains stretch more than 4,800 km.
- Spread along northernmost part of British Columbia, in western Canada, to New Mexico, in the southwestern US.
- Located within the North American Cordillera, the Rockies are distinct from the Cascade Range and the Sierra Nevada, which all lie farther to the west.

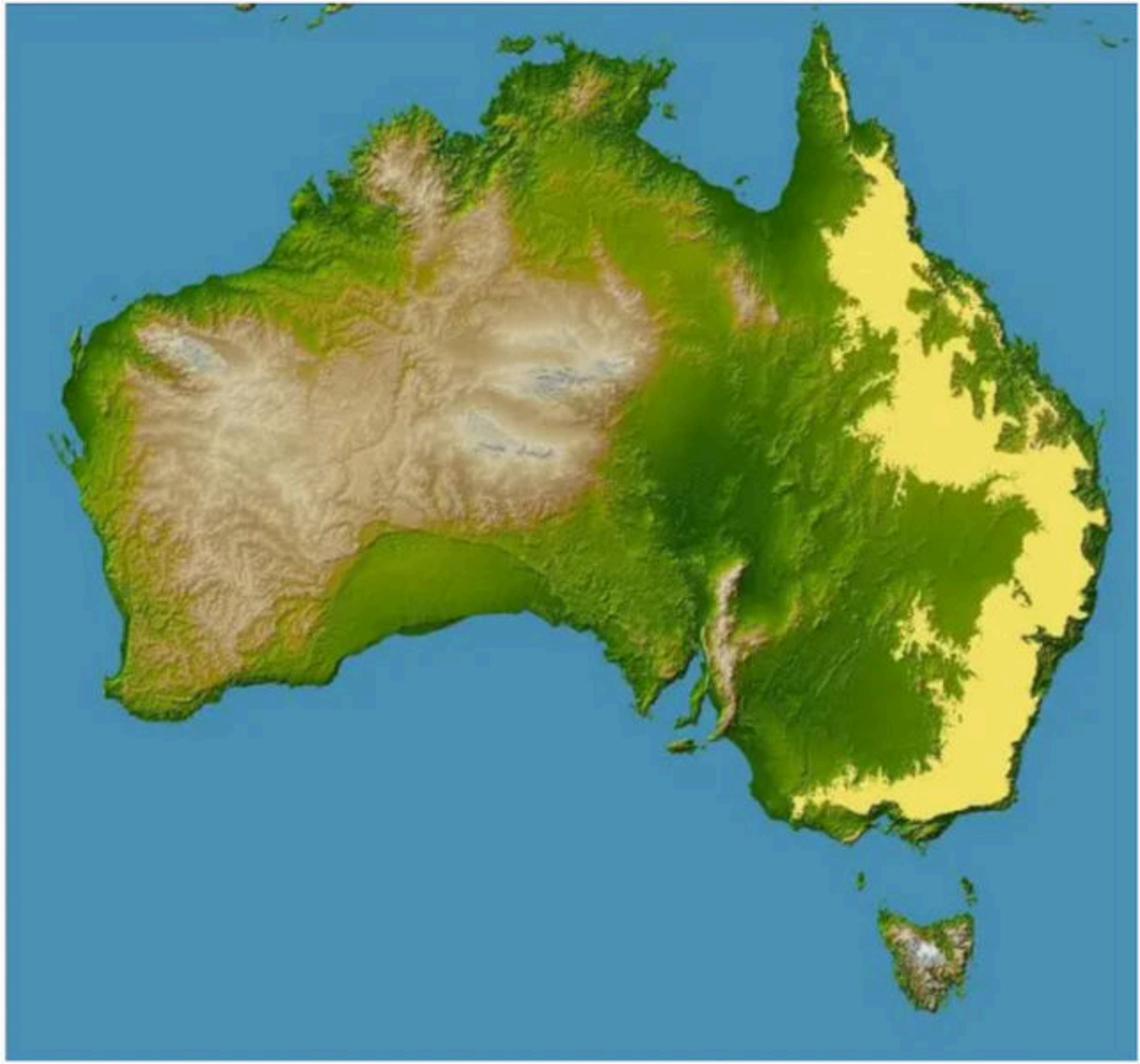


Geology

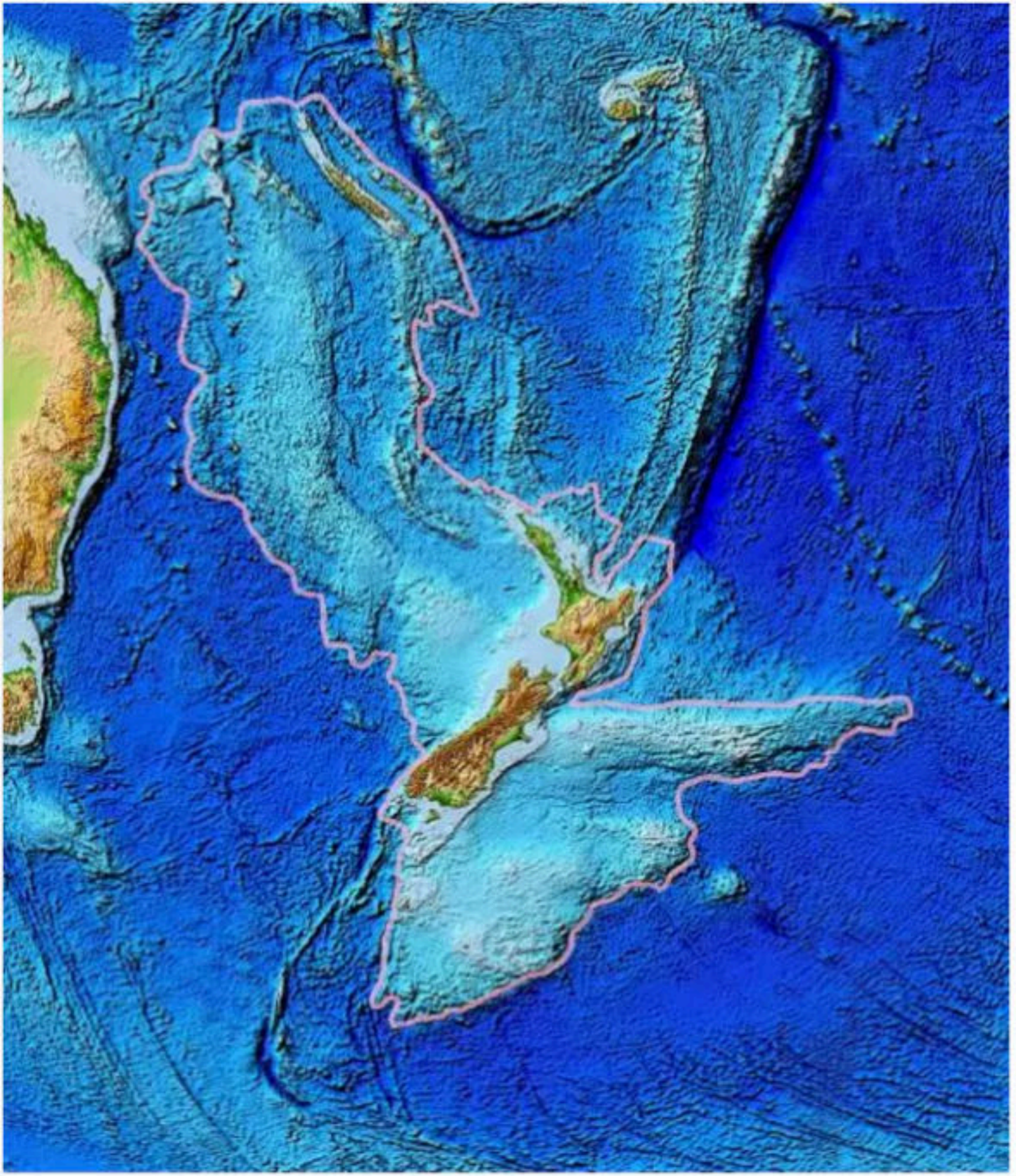
- Formed due to Ocean-Continent collision 80 m.y.a. to 55 m.y.a. ago.
- Took shape during an intense period of plate tectonic activity that resulted in much of the rugged landscape of the western North America.

GREAT DIVIDING RANGE

- The Great Dividing Range, or the Eastern Highlands, extends from Cape York Peninsula (Queensland) to Victoria and continues beyond the Bass Strait into Tasmania (for more than 3,500 km).
- Name was given for its function of dividing watersheds, which determines the direction of flow of many rivers.
- It is also known as the **Australian Alps**. The Greater Blue Mountains Area, Gondwana Rainforests and Wet Tropics of Queensland World Heritage Areas are located in the range.
- Highest Point : Mt. Kosciuszko (2,228 m)
- It was formed due to rifting (divergent boundary).



- Two processes, continental collision and volcanism, were responsible for most of the world's mountain ranges. Australia's Great Dividing Range, however, happened without either, puzzling geologists as to its source. Finally, they have an answer, one that may also explain highlands elsewhere.
- University of Sydney's Professor **Dietmar Müller** Research has explained that these mountains are the product of two successive rounds of uplift. From 120 to 80 mya, East Gondwana began to break up and its continental slab sank. "Eastern Australia was drifting over a subducted plate graveyard, giving it a sinking feeling. But around 100 mya subduction came to a halt, resulting in the entire region being uplifted, forming the Eastern Highlands."
- Müller explained that sinking as a result of subduction is followed by a rebound. However, this effect only raised the area by 400-600 meters. The northern highlands continued to rise, albeit slowly, while the southern end didn't change much, aside from some erosion.
- "Then, about 50 mya, Australia's separation from Antarctica accelerated and it started moving north-northeast, gradually taking it closer to a vast mantle upwelling called the South Pacific Superswell. This provided a second upward push to the Eastern Highlands as they gradually rode over the edge of the superswell."
- The team's modeling has been confirmed by a study of river systems in the Snowy Mountains at the southern end of the Great Dividing Range, which show signs of having cut through the mountains in a two-stage process. Erosion records from offshore basins also support the theory.



Zealandia

It is an almost entirely submerged mass of continental crust that subsided after breaking away from Gondwanaland 83–79 million years ago.

It has variously been described as a submerged continent, a continental fragment, a microcontinent, and a continent.

The name and concept for Zealandia was proposed by Bruce Luyendyk in 1995.

The landmass may have been completely submerged by about 23 million years ago, and most of it (94%) remains submerged beneath the Pacific Ocean.

New Zealand is the largest part of Zealandia that is above sea level, followed by New Caledonia.

TRANSANTARCTIC MOUNTAINS

These comprise a mountain range of uplifted sedimentary rock in Antarctica which extend, with some interruptions, across the continent from Cape Adare in northern Victoria Land to Coats Land.

These mountains divide East Antarctica and West Antarctica. They include a number of separately named mountain groups, which are often again subdivided into smaller ranges.

The range was first sighted by James Clark Ross in 1841 at what was later named the Ross Ice Shelf in his honor.

The mountain range stretches between the Ross Sea and the Weddell Sea, the entire width of Antarctica, hence the name.

With a total length of about 3,500 km, the Transantarctic Mountains are one of the longest mountain ranges on Earth.


KONG HÅKON VII HAV
SOUTHERN OCEAN
WEDDELL SEA
ANTARCTIC PENINSULA
DRONNING MAUD LAND
ENDERBY LAND
KEMP LAND
COATS LAND
MACROBERTSON LAND
EAST ANTARCTICA
RONNE ICE SHELF
PRINCESS ELIZABETH LAND
BELLINGSHAUSEN SEA
South Pole
Amundsen-Scott (USA)
WILHELM II LAND
ELLSWORTH LAND
Transantarctic Mountains
WEST ANTARCTICA
QUEEN MARY LAND
AMUNDSEN SEA
MARIE BYRD LAND
ROSS ICE SHELF
WILKES LAND
ROSS SEA
TERRE ADÉLIE
GEORGE V LAND
VICTORIA LAND
60°S
70°S
80°S



URAL MOUNTAINS

- Mountain range that runs approx. from north to south through western Russia, from the coast of the Arctic Ocean to the Ural River and northwestern Kazakhstan.
- Their eastern side is usually considered the natural boundary between Europe and Asia.
- Rich in various deposits, including metal ores, coal, precious and semi-precious stones.
- Since the 18th century, the mountains have been a major mineral base of Russia.

Geology

- The Urals are among the world's oldest extant mountain ranges.
- Formed due to **Continent-Continent collision**.
- They were formed during the Uralian orogeny due to the collision of the eastern edge of the supercontinent **Laurussia** with the young and weak continent of **Kazakhstania**, which now underlies much of Kazakhstan. The collision lasted nearly 90 million years in the late Carboniferous-early Triassic.
- Unlike the other major orogens of the Paleozoic (Appalachians, Caledonides), the Urals have not undergone post-orogenic extensional collapse and are unusually well preserved for their age. For its age of 250 to 300 million years, the elevation of the mountains is unusually high.

ATLAS MOUNTAINS

- Mountain range across the northwestern stretch of Africa extending about 2,500 km through Algeria, Morocco and Tunisia.
- The highest peak is Toubkal, with an elevation of 4,165 m in southwestern Morocco.
- Separates the Mediterranean and Atlantic coastlines from the Sahara Desert.

Geology

- Initially, these mountains were formed when Africa and America collided (North America, Europe and Africa were connected millions of years ago), and were once a chain rivaling today's Himalayas.
- Finally, in the Paleogene and Neogene Periods (66 million to 1.8 million years ago), the mountain chains that today constitute the Atlas were uplifted, as the land masses of Europe and Africa collided at the southern end of the Iberian Peninsula.
- Some remnants can also be found in the later formed Appalachians in North America.
- Rich in natural resources – Deposits of iron ore, lead ore, Cu, Ag, Hg, rock salt, phosphate, marble, anthracite coal and natural gas among other resources.



APPALACHIAN MOUNTAINS

- System of mountains in eastern North America.
- One of the major mineral bases of America (contain major deposits of anthracite and bituminous coal, petroleum and natural gas).

Geology

- A look at rocks exposed in today's Appalachian mountains reveals elongated belts of folded and thrust faulted marine sedimentary rocks, volcanic rocks and slivers of ancient ocean floor, which provides strong evidence that these rocks were deformed during plate collision.
- The birth of the Appalachian ranges, some 480 million years ago, marks the first of several mountain-building plate collisions that culminated in the construction of the supercontinent Pangaea with the Appalachians near the center.
- Because North America and Africa were connected, the Appalachians formed part of the same mountain chain as the Little Atlas in Morocco.

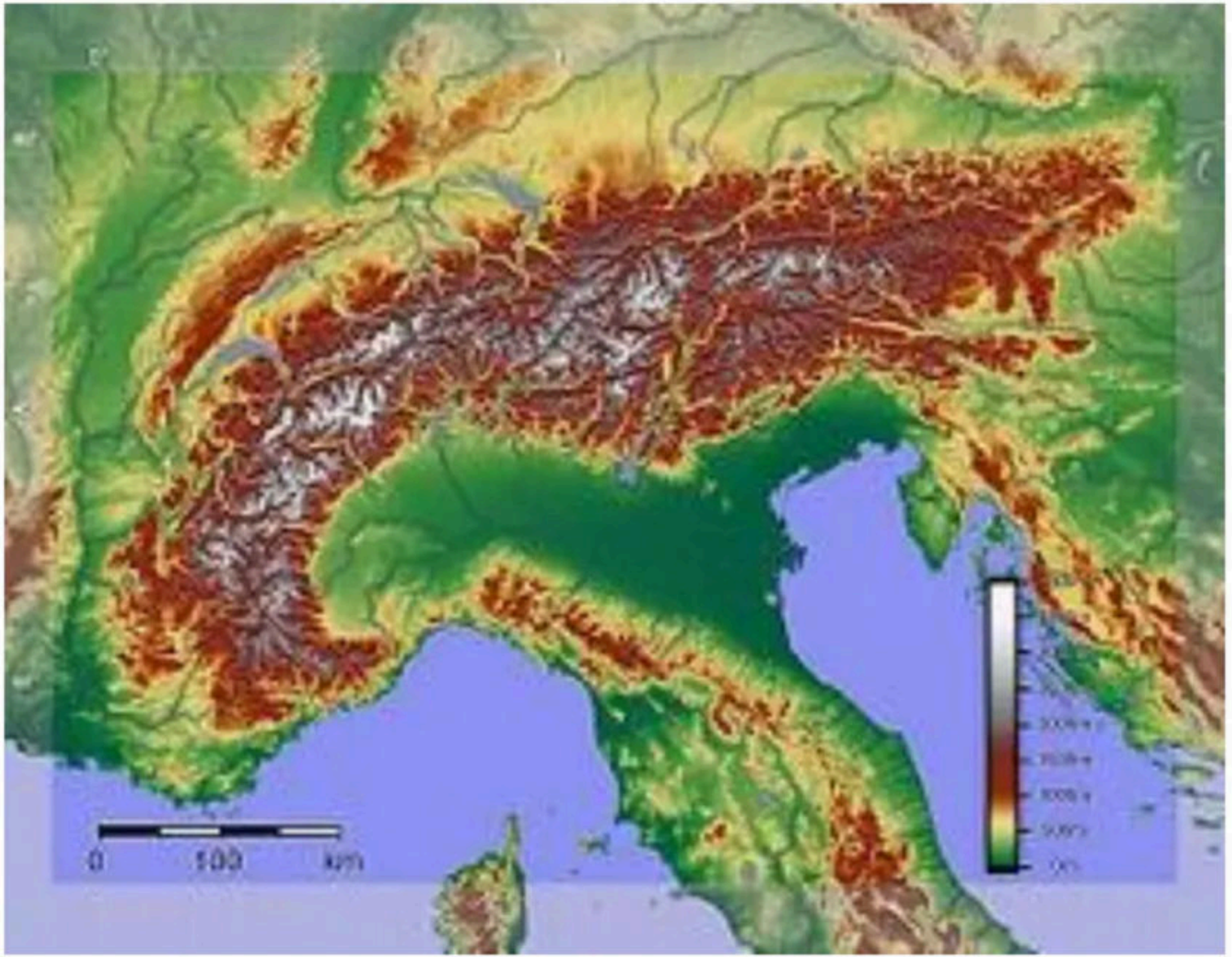


ALPS

- Stretches approx. 1,200 km and spread across eight Alpine countries from Austria and Slovenia in the east, France, Switzerland, Liechtenstein, and south east Germany, to the west, and Monaco and Italy to the south.

Geology

- Formed when African and Eurasian tectonic plates collided.
- Extreme shortening caused by the event resulted in marine sedimentary rocks rising by thrusting and folding into high mountain peaks such as **Mont Blanc** and the Matterhorn.
- Mont Blanc spanning the French-Italian border, at 4,810 m, is the highest mountain in the Alps.
- The Alpine region area contains about a hundred peaks higher than 4,000 m, known as the "four-thousanders".
- The altitude and size of the range affects the climate in Europe; in the mountains precipitation levels vary greatly and climatic conditions consist of distinct zones.



10 AM

200 w ✓

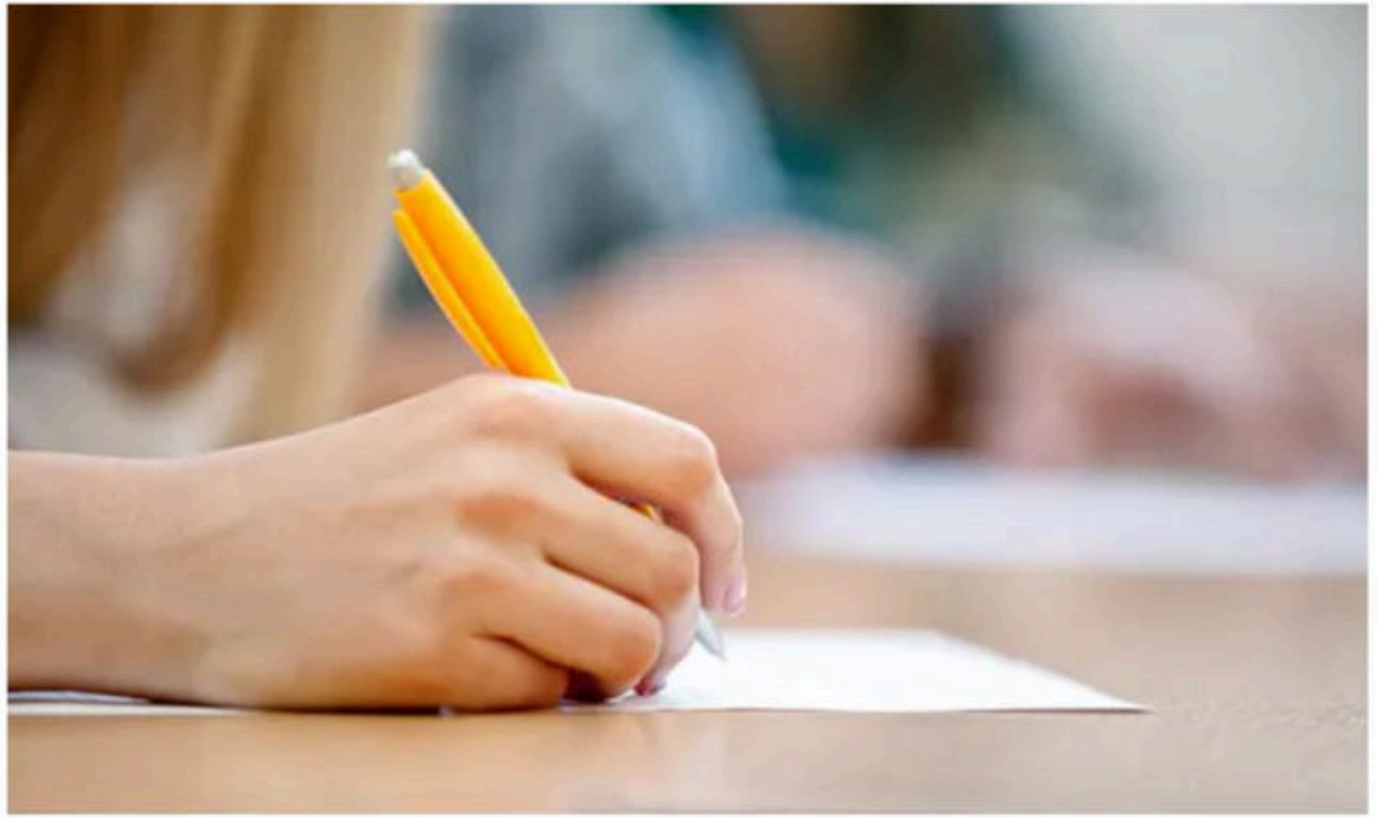
½ hr

Longest Mountain Ranges

1. Andes – 7,000 km
2. Rocky Mountains – 4,830 km
3. Great Dividing Range – 3,500 km
4. Transantarctic Mountains – 3,500 km
5. Ural Mountains – 2,500 km
6. Atlas Mountains – 2,500 km
7. Appalachian Mountains – 2,414 km
8. Himalayas – 2,400 km
9. Altai Mountains – 2,000 km (1,243 mi)
10. Western Ghats – 1,600 km
11. Alps – 1,200 km
12. Drakensberg – 1,125 km
13. Aravalli Range – 800 km



Mains Answer Writing



by Tarun Goyal

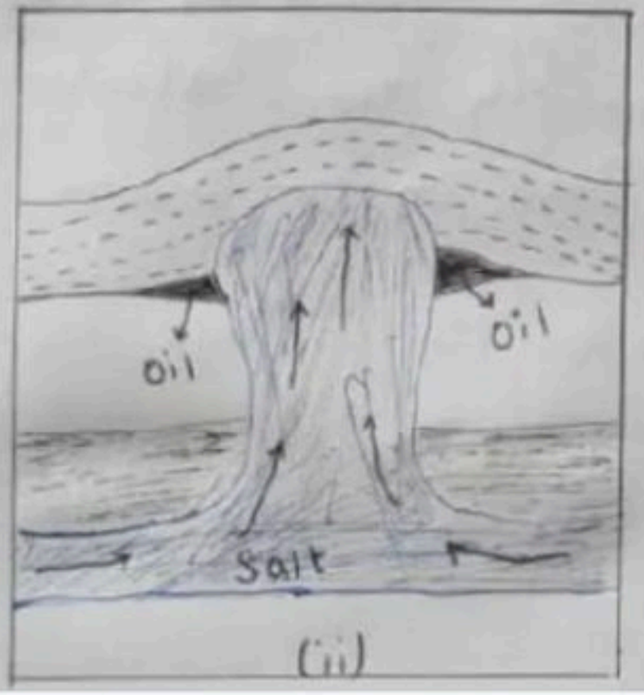
Qus: What is pseudo volcanic features?

Ans: Pseudo volcanic features are certain topographic features that resembles volcanic form but are of non-volcanic in Origin. They Include the following.

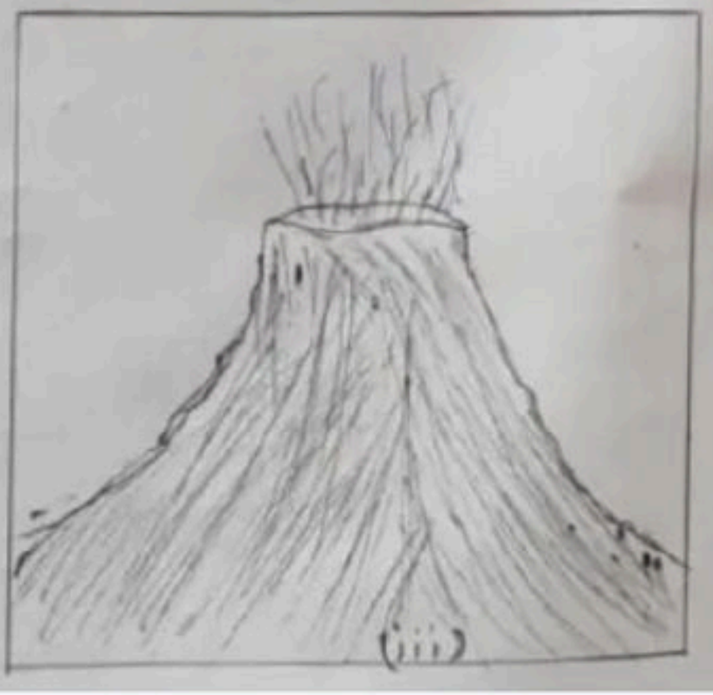
i) Meteorite Craters → A bowl-shaped depressions formed due to the impact of falling materials of large dimensions.
eg. Lortar Lake (Buldana, Maharashtra)



(i)



(ii)



(iii)

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ii) Salt-plugs / Salt dome → • A raised dome like structure of stratified rocks containing a central core of salt formed by upward push from high pressure side.
• Salt extrusions take form of salt hills which exhibits many features of plug domes

iii) Mud-volcanoes → • Mud volcano is created by geo-excreted gas and liquids.
• Usually found in subduction-zone.
• Generally gas released consists Methane majorly
eg. Baku on the Caspian

Thus Geomorphology consists of variable landforms which may appear same but have distinct features such as "all Animals are not Human but they serve humanity well".

Pranjal Singh
approx 200 words
15 min.

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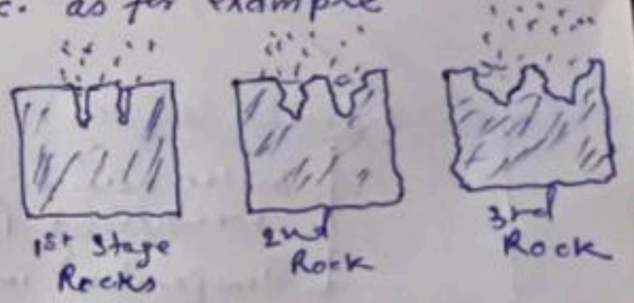
Q3. "Weathering is a Complex Phenomenon involving a number of Process and is influenced by various factors". Elaborate.

Ans Weathering is exogenic process in which disintegration and decomposition of Rocks took Place through various geomorphic agents like water, Ice, Temperature etc.

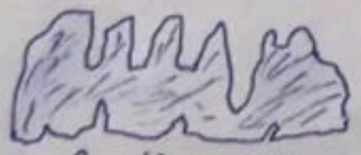
Weathering Can be Classified as Physical, Chemical and Biological Process.

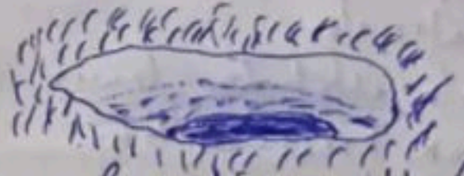
(i) Physical Process :- In this Process rocks broken down into smaller segment without loosing there Chemical Properties with the help of gravitional force and Expansion force etc. as for example

(a) Thermal Expansion and Contraction
(b) Freezing Thawing and Frost wedging
(c) Exfoliation



(ii) Chemical Process :- In this Process rocks Changes their molecular structure due to presence of water and various gaseous element. In the form of Solution, Carbonation, oxidation / Reduction. etc.


Reaction with water


Reaction with Acid

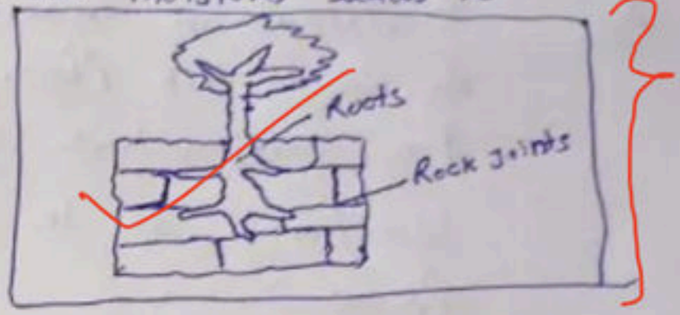
Shefali

REDMI NOTE 8 PRO

(iii) Biological Process :- In this Process weathering took Place by the growth of organism. as for Example.

(a) Plants roots Penetrate the rocks which Contain moisture leads to disintegrations.

(b) Anthropogenic activity like, cultivation, mining leads rocks disintegrate.



→ The two Process Influence the weathering

(i) Exogenic Process

(ii) Endogenic Process

Climatic Condition
- water need for virtually every weathering Process
- Temperature influence rate of weathering

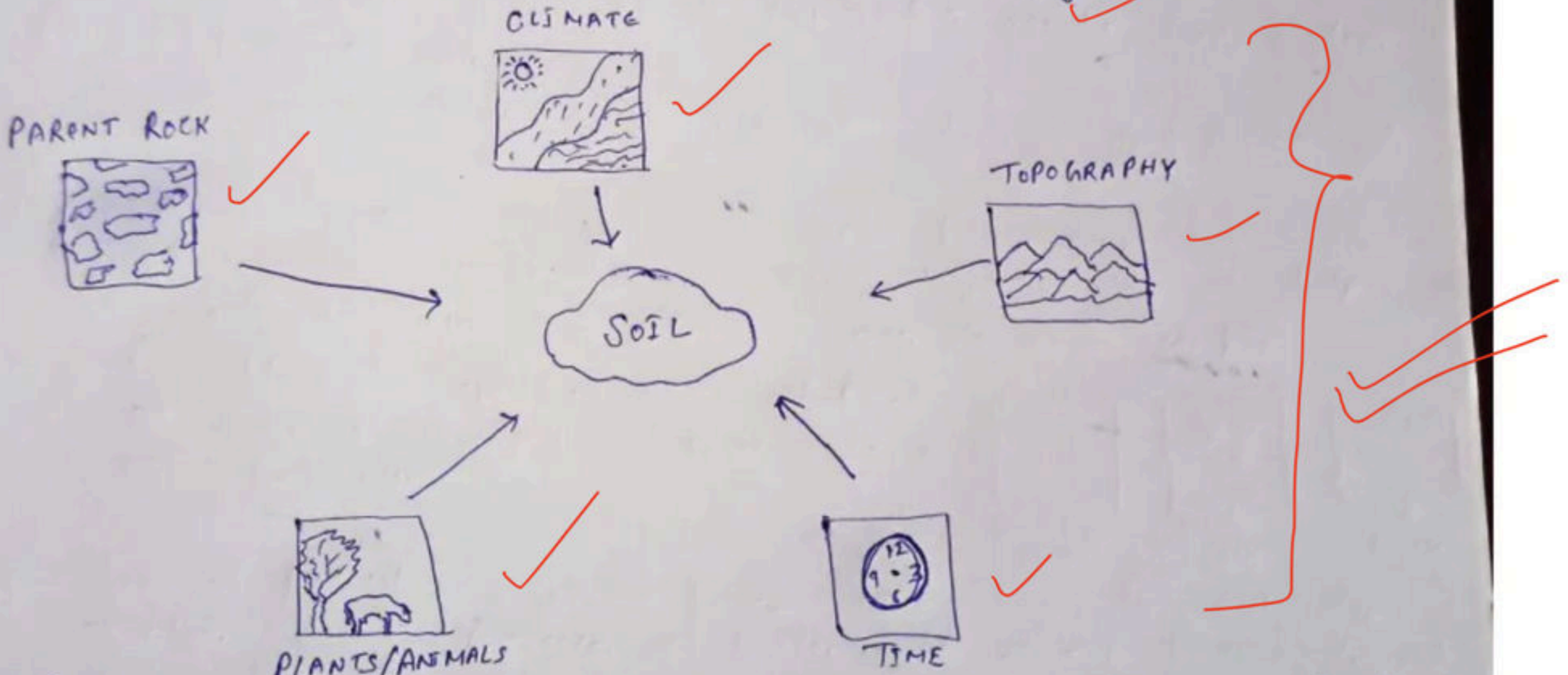
Topography/Relief
- Steep Slope help transport weathered materials.
- high altitude lower temperature took Frost action.

Properties of Rocks
- weak rocks get weathered more easly than Stronger rocks (granite vs Sandstone)

Minerals and Chemical Composition
- determine degree of susceptibility to weathering

Human Activity →

- Air Pollution Create more acidic rainwater.
- agriculture, mining remove overlying rocks.

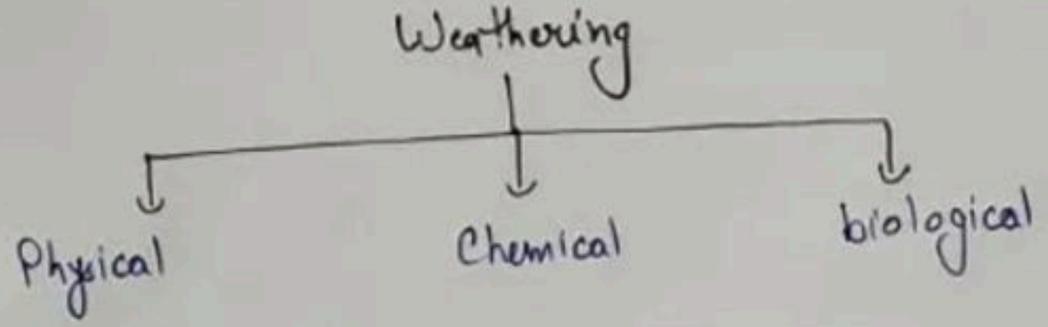


Therefore, understanding these Phenomenon Can help us better understand the world around us and how it was made and How it will Continue to be Shaped by these process.

① "Weathering is a complex phenomenon involving a number of processes and is influenced by various factors." Elaborate.

Weathering is subaerial process affected by exogenic activities which may distrub or disintegrate the structure of rocks in in-situ. Weathering also depend on some other factor like topography, relief, climatic conditions.

Types →



Physical weathering → It mainly involves disintegration of rocks without chaning its chemical composition.

i) Exfoliation due to temperature (tem) & pressure → Onion structure peeling & occurs in this process. Due to temp. the rocks is disintegrated into small fragments & then upper layer of rocks is peeled off then the superincumbment pressure decreases & then new layer also affected by temp. Thus it is a cyclic procen.

ii) Unloading due to temp. & pressure → Sunlight penetrate some deep inside the rocks this can cause breaking down of structure of rock. The layer is ~~re~~unloading

by tem. This is due to contraction & expansion of rocks.

iii) Fraging & thawing of rocks → When the water freg in the cracks & faults when temp. is very low. but due to diurnal change of temp. cause melting of ice. In this process water expands upto 9% when in freezed condition which may create disintegration of rocks.

iv) Granular disintegration of rocks → Due to high temp. in arid area like desert rocks are disintegrated into very small sand like structure due to diurnal change occurs. Low temp. at night create contraction of rocks but on the other side at day expansion occur in rocks due to high temp cause weathering of rocks

v) Due to shattering & drizzling can develop cracks in the rocks.

⑨ Biological weathering → weathering also effected by flora & fauna & other microorganisms.

1) Due to flora & fauna → Presence of fauna creates a microclimate which can creates little bit reduce temp in that area & give shelter to other microorganisms. which can create environment to change some structure of soil. Many reptiles & animal dug hole in the rocks to take shelter & reduces the integration of particles in rock.

Many anthropogenic activities also affect the like minning industrial expension. South africa gold mine is good exple example of man made disturbance.

Chemical weathering → It changes the structure of rocks with oxidation, reduction & many other process.

i) Oxidation & reduction → Dissolving of water & presence of oxygen change the structure & its chemical composition. like Red soil is red in colour due to presence of minerals like Fe, magnesium. but when it hydrated it changes in grey in colour.

Weathering is main causes of creating & destroying of landforms in a particular area.

Q Weathering is complex phenomena involving number of process and is influenced by various factors. Elaborate.

Ans. " Karat Karat abhyas se Jadmati Hot Sujaan
Rasri Anat Jaat se sill par padat Nisaan "

The phrase itself shows marks of removing/removal of parent rock due to external process it can be biotic or abiotic.

Short
K
S
S.

Abiotic

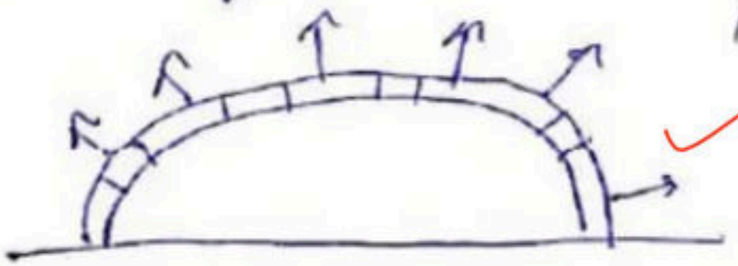
→ Physical — Temperature, Air, water etc.
→ chemical — Acid rain etc.

Biotic

→ organic
→ Anthropogenic.

Physical weathering

Temperature dependend → Diurnal range of temperature leads to contraction and expansion causes cracks in regolith and esp exfoliation.



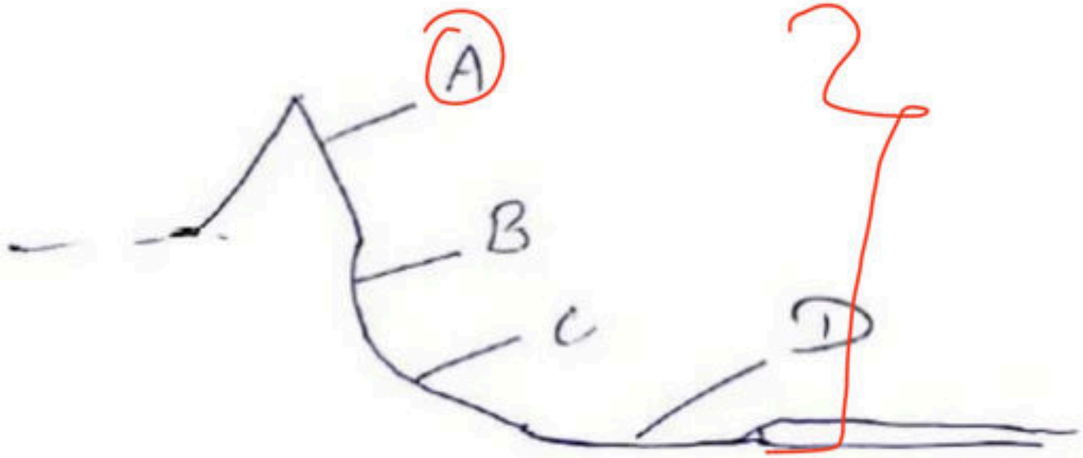
Removal of layer.

Water dependent → Biggest example is rivers how they make able to break down of rock.

Organic → Some times we see growth of algae, lichens and even fig [peepal] tree inside the small gaps of rock which leads of breakdown of parent material. It is termed under Biotic weathering.

Anthropogenic weathering → Since humans are major responsible in today's processes of weathering by different means infrastructure, roads, mining etc and causing weathering at large scale.

Process :-



A → Weathering depends upon slope so it will take place at this gradient

B → Minimum as almost parallel or perpendicular to base rock. so weathering agent will flow freely.

c → Weathering will be very high as angle of inclination is about 45° suitable for max weathering.

d → Maximum deposition will take place as due to upper material get deposited but weathering will be very high.

Weathering rate. B > A > C

C > d > A > B

Weathering is a dynamic process which has been under process since the origin and its are a never ending cycle the break down of parent rock (regolith) on its position is termed under this thus it is a insitu process.

Write a short-notes on sea floor spreading Theory :-

Answer :-

"Life is a circle, widening until it joins the circle motions of the infinite".

This theory also explains the same, ie its all about evolution of oceanic crust & distruction of oceanic crust. & other associated phenomenon.

1) Theory is Explained by geologist harry hess in 1960. Based on convectional current theory of "Arthur Holmes"



2) It helps, in Evolution of Plate tectonic theory.

3) Theory explains the Movement of oceanic Plates

4) Forces applied for the movement of the oceanic plate was convectional current

5) Limitation of theory is that it was unable to Explain the movement of continental plate

6) Evidences shared in support of the theory was ocean bottom relief distribution of EQ & volcano Paleomagnetism etc.

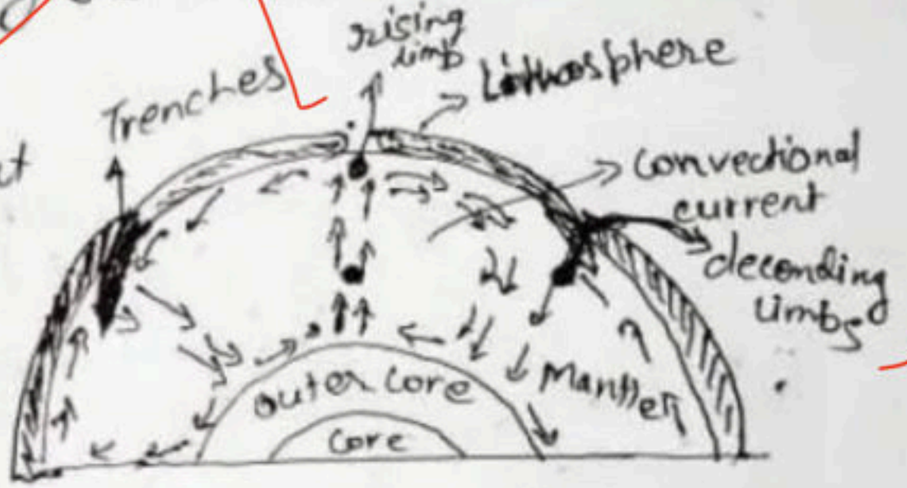
⇒ To understand sea-floor spreading theory first we need to understand convectional current theory explained by Arthur Holmes

Convectional current theory "radioactive

noted that radioactive decay of substances led to generation of heat that creates magma deep benith the Eath at (mantle).

Magma consists of molten rocks & dissolved gasses, which wants to Escape under high pressure & temperature which led to formation of convectional current in the mantle - for example how how under high temperature gases dissolves in water Evaporate.

Theory explains that at the rising limbs of convectional current to Continu - ous hammering



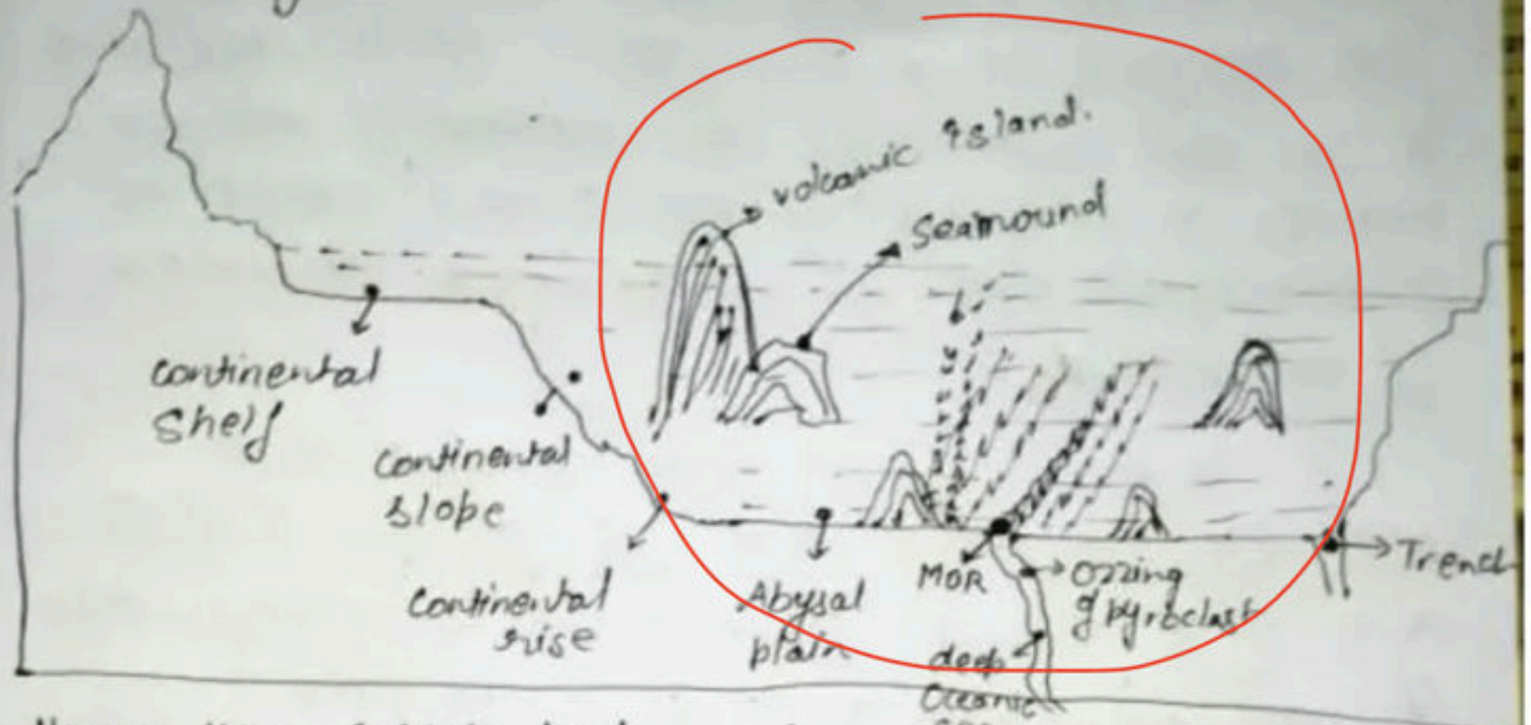
400 w - 600 w

Effect of ~~sea floor~~ on lithosphere divergent boundary form & at the decending limbs convergent boundary forms.

On, the basis of this theory Harry Hess explains the sea floor spreading theory in 1960 when germany had developed sever sub-marine, ~~ships~~ ~~what~~ with the help of that they explore the deep oceanic floor and found more diversity as compared to the continental crust.

while travelling from the continents to the mid of the ocean they noticed that there is rise in the ocean temperature And then they concluded it is because of the Divergent boundary where magma

is occuring.



Harry Hess explains that sea floor-spreading took place at Divergent limbs of the convectional current where magma erupts & continuously forms new oceanic crust at MOR (Mid-Oceanic Ridge) By partitioning of the previous layer, & this can be observed by the equidistant sea mound with same age and chemical composition as well as paleomagnetic status of it

Then he farther argued that if only creation of oceanic plate took place, then Earth size would have been increased till date But its not true, hence there must be a place of distruction, And then he explains "Trenches" as it is formed between the End of oceanic crust & start of continetal crust or we can say that at the convergence of oceanic as continetal crust as a "distructive boundary" He, explains that trenches ~~were~~ have must formed at the alecending limbs of the convectional current and as at the end of conveyer belt rings

get crushed similarly ~~Earth~~ oceanic crust get detroyed at it margin ie at 'trenches" and it can be noticed by the dilation of the sea mounds, & thickness of the oceanic crust as it increased due to weathering & distruction of sea mounds.

In this way we can conclude that sea floor spreading is a cycle of life & death. is a cycle of birth - death - and recreation, also it can be considered as a transition zone between Alfered wagener's "continental drift theory & plate tectonics theory which is explained by a "group of geologist"

Q. Discuss the limitation of the theory of continental drift and show how the theory of plate Techtonics is an improvement over it.

– Alfred wegner in 1912 gave the theory of continental drift which states that continent have moved away from each other in a period.

According to wegner, from 225 millin year before present 'Pangea' a single continent was present surrounding a ocean 'Panthalassa'. Then, each continent started drifting away from each other. For this movement, he profounded the reason of tidal forces, gravity, rotation of the earth and buoyancy.

However, this theory had its limitations which made other scientists to discard it. Theory of plate techtonics was used to confirm the limitations. Plate Techtonics declined tidal force for movement and proposed 'convection current theory' as the reason for the movement. Also plate techtonics theory gave the concept of lithospheric plates which moves above asthenosphere.

Limitations of continental drift which are overcamed by plate techtonics theory explained below:-

1) Force for the movements of continent -

Plate techtonic says there is a movement of plates over asthenosphere not ~~on~~ of continent i.e. SIAL over SIMA. Citing limitation of tidal forces to move such a large continents it says ~~presen~~ presence of convectional current present below earth responsible for the movement.

2) Oceans —

CDT fails to provide any reason for formation of Oceans and its relief structure. While PTT overcomes this by citing presence plate boundaries likee ocean - continent, ocean-ocean etc. Also, It proves that ocean floor is younger and heavier than the continent. Presence of rift, trench is also well explained by PTT.

3). Volcanic Islands -

Recent studies shows that volcanic Islands i.e. Archipelagoes are formed newly and were not part of original continents. This is also explained by PTT but not by CDT.

4) Mountain formations -

CDT fails to explain the formation of fold, block mountains present today, while plate techtonics well explains its formation citing presence of continent - continent & ocean - continent convergent boundaries.

5) Evidences -

CDT failed to provide any valid and acceptable reason for the movement. Reasons provided ~~where~~ were silly and illogical in some cases. Evidences PTT provided are widely accepted and more logical and explains most of the things present over earth.

At the end, though there were many limitation to CDT but it ~~does~~ made a strong foundation for further theories and also challenged the existing theories of that time.

(P1)

Discuss the limitations of the CDT & show how theory of Plate Tectonics is an improvement over it.

To explain the present distribution of oceans & continents various theories has been proposed. First speculation was put forward by A. Ortelius followed by Snider Mantovani & Taylor. Continental drift theory (1912) by A. Wegner is considered a pivotal theory which provided various conclusive proofs to establish the ~~movement~~ movement of crust but failed to establish mechanism behind the process

have

According to Wegner the drift was in 2 direction.

1) Equator wards (due to cumulative effect of Gravity, Pole fleeing force & buoyancy)
2) Westwards (due to tidal currents)

→ Wegner gave multiple evidence to justify his theory (Fig 1)

Much of the theory was based on speculation & inadequate ~~evidence~~ evidence that it provoked a lot of criticism

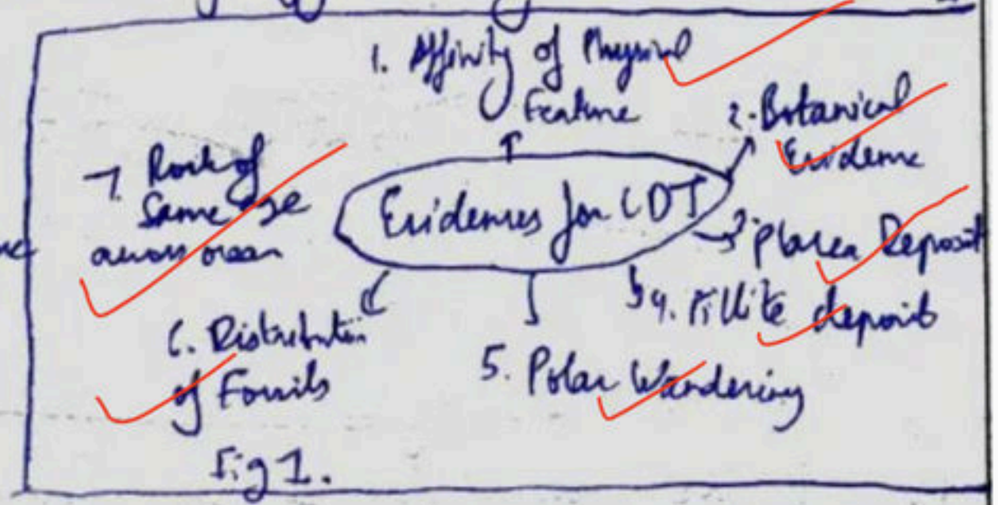


Fig 1.

Limitations

1) Forces invoked by Wegner inadequate to cause drift
2) Did not take oceans into consideration
3) Wegner accepted Suess theory that SIAL floating over SIMA. But this assumption was wrong
4) Could not explain Volcanic origin of Philippines, Indonesia etc. and Fold Mt ~~like Himalaya~~
5) Fossil evidence questioned by Theory of Nonoplasy

The Limitation of this Theory was further rectified in Plate Tectonic Theory (PTT)

Plate Tectonic Theory

1) According to this theory Earth's [Lithosphere] is broken into distinct plates which move [floating] on a layer called [Asthenosphere]

2) Theory deals with movement of [both] Rock Structures & Oceans

3) The movement of these [tectonic plates] caused the formation of various landforms & is also [Fold mts] [Islands] & thus explains the formation of

4) It also solved the major lacuna in CDT by Wegner i.e Power. It adopted the [Convectional Current Theory] of proposed by Arthur Holmes. Due to this theory magma heat & gases generated within the Earth due to [Radioactive Decay] & [Residual Heat] seek a path to escape which leads to the formation of convection current (Fig 2)

formation of convection current (Fig 2)

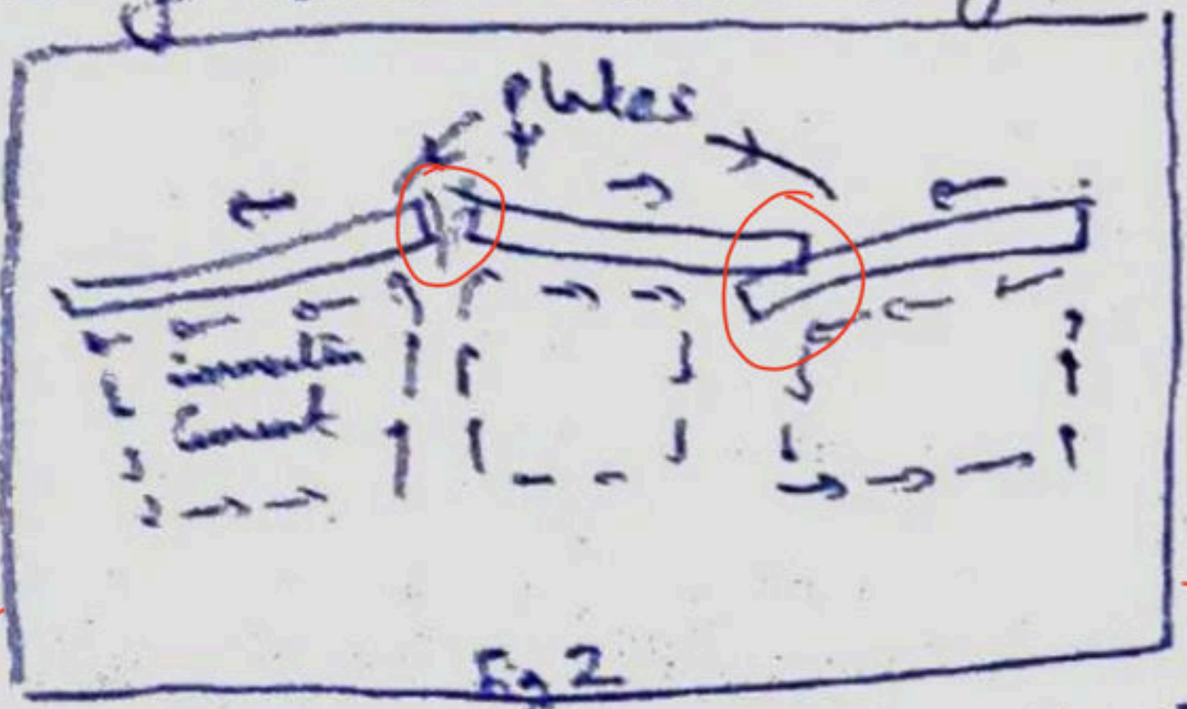


Fig 2

Despite its omissions & commissions CCT helped in the evolution of Conventional Current Theory, which helped in turn in the evolution of Plate Tectonic Theory, which helped us understand various geographical features.

Q2. Write a short note on geomagnetism & Palaeomagnetism

* Geomagnetism →

- It's a study of magnetic field of the earth that is formed within the core of earth, due to.
- Outer core of the earth is made up of Nickel and iron & is in molten state.
- Due to combined effect of transfer of Heat from inner core &, coriolis force & convections currents dynamo effect is produced & magnetic field is formed. It goes from inside to outer space.
- earth is said to have a hypothetical 'bar magnet' inside it & it is dipolar
- Magnetic poles of earth are dynamic and are inclined at 11° from to its rotational axis.
- Magnetic poles change their polarity i.e. they reverse the position.
- Magnetic field is not the same all over the earth, it is more at poles & is measured in 'Gauss'.
- current location - Ellesmere Island.

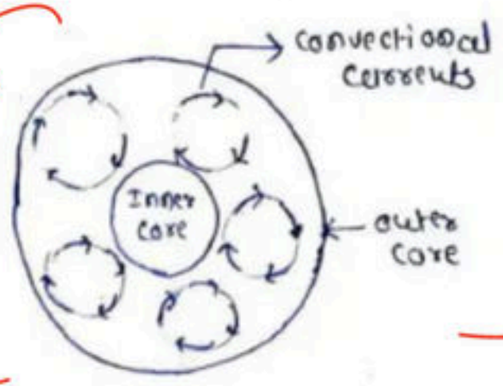
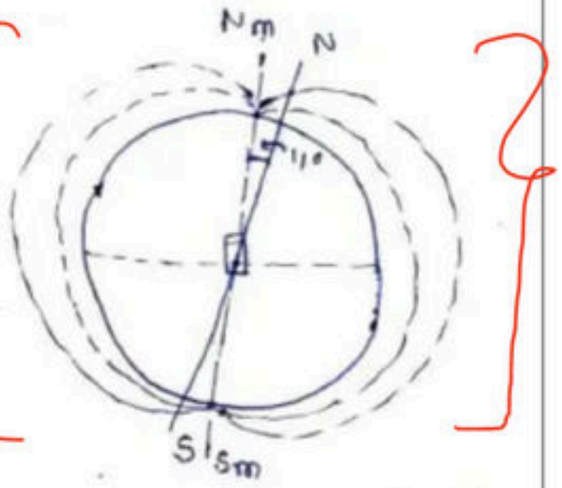


fig. core



N, S → Geographical poles

Nm, Sm → Magnetic poles

* Uses of Geomagnetism →

- Helps in navigation
- protects earth from solar flares of sun.
- helps some migratory birds use magnetic field to travel.
- Helps in communication technologies

* Reversal of poles →

- How do we know that polarity of the earth's magnetic field changes?
- Palaeomagnetism comes into the picture here.

* Palaeomagnetism →

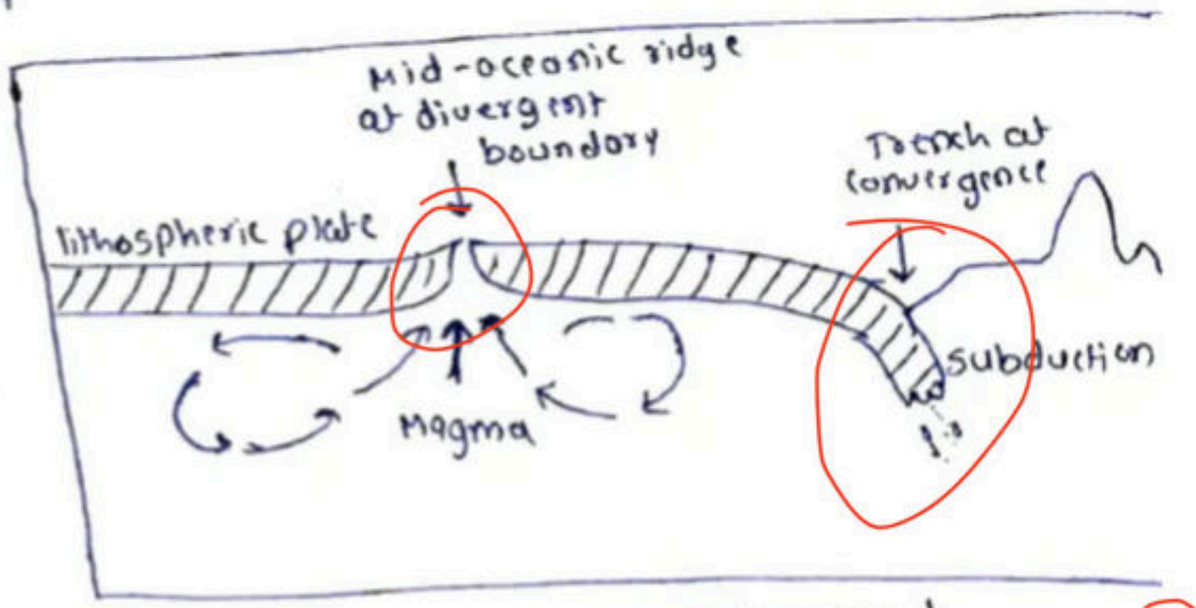
It is the study of magnetized rocks'.
Palaeomagnetism is the biggest support to sea floor spreading theory and continental drift

Theory and continental drift

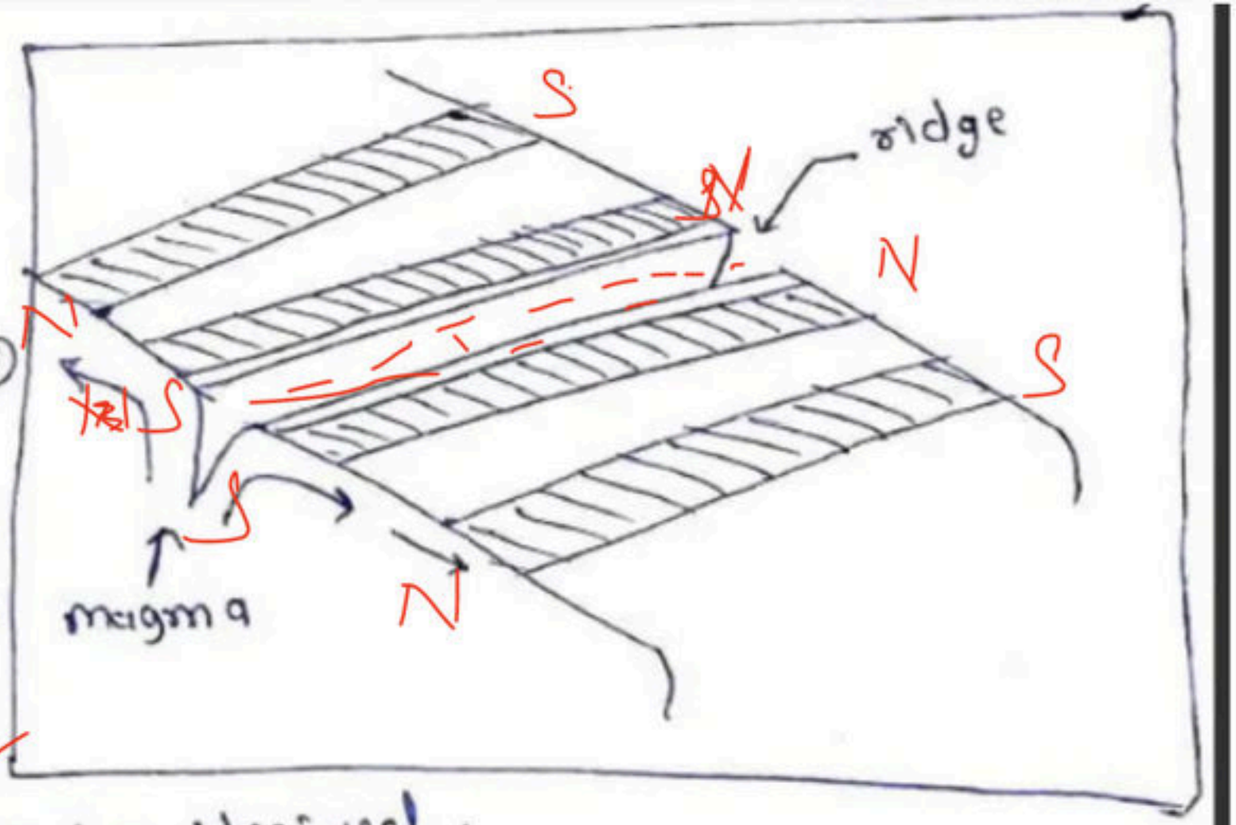
- **Sea floor Spreading** →

Due to convectional currents, convergent & divergent limbs are formed.

- These are responsible for the movements of plate
- convergent boundary → Two plates collaid and one plate Subducts → It is a destructive boundary → Trenches are formed
- divergent boundary → plates divert → constructive → ridges are formed.
- Shear boundary → No Pass by → no construction or destruction
- now when ridges are getting formed, magma is continuously coming out and forms a new crust → Before Sol. cooling down completely rocks align themselves with the then magnetic field of earth and ~~are~~ get magnetized



- These strips magnetic strips are formed on both sides of the ridge and these strips have are alternate & parallel.
- normal (positive) & reverse (negative) magnetic anomalies are found
- There is also parallelism in time sequence of palaeomagnetic events
- From age of these strips, rate of sea floor spreading can be derived.



* Thus palaeomagnetism also supports geomagnetic reversal of polarity with proof, And has helped in to form staunch views on sea floor spreading.

3. Weathering is a complex phenomenon involving a number of processes and is influenced by various factors. Elaborate.

Weathering is the process of disintegration of rocks due to mechanical and chemical processes. It is a type of process caused by the exogenetic forces mainly the temprature variation caused by Sun.

It can be classified as – (on the basis of process involved)

1. Physical weathering
2. Chemical weathering
3. Biological weathering

Physical weathering is due to physical process such as, temperture change, unloading, freezing and frosting, due to heavy rain shower this type of weathering further classified on their technique involve (cause of disintegration)

Exfoliation / Onion weathering is due to alternate expansion & contraction due to change in temp. of day & night in hot arid or semi-arid region (desert). This differential expansion of rock outer layer cause flaking. (disintegration of outer layer of rock as a shell)

Thermal expansion & contraction of the surface weaken the bond of molecule of the rock & lead to disintegration

In case of the rock which is made up of the different type of coarse-grained mineral which have different capacity to absorb the heat will expand & contract at different amount of hot & cold temprature. This lead of mineral grains resulting in grain-by-grain disintegration from rock

freezing & thawing & frost wedging is the process in which, at the place where rapid freezing & melting of water takes place, this causes the sudden expansion & contraction of rock & cause to disintegrate.

Similarly there are lots of chemical process such as in the presence of water lots of chemical reaction takes places hydration oxydation & carbonation, Reduction these are the principle reason to cause the disintegration of rock.

Biological weathering is caused by biological, Anthropogenic activity (mainly due to flora & fauna)

- grazing of animals, ploughing by human being.
- cracks are widened by penetration of roots
- dense vegitation cover & create a distinct microclimate at the ground surface & the affect the soil atmosphere which can cause a new environment of microorganism which can take part in the weathering (by organic or chemical change)

Hence it is clearly visible by deep observation that weathering is a very much complex process & involves faction factor & also not individually responsible for it. All are combinely affect the rock & all are indirectly connected process.

10 AM

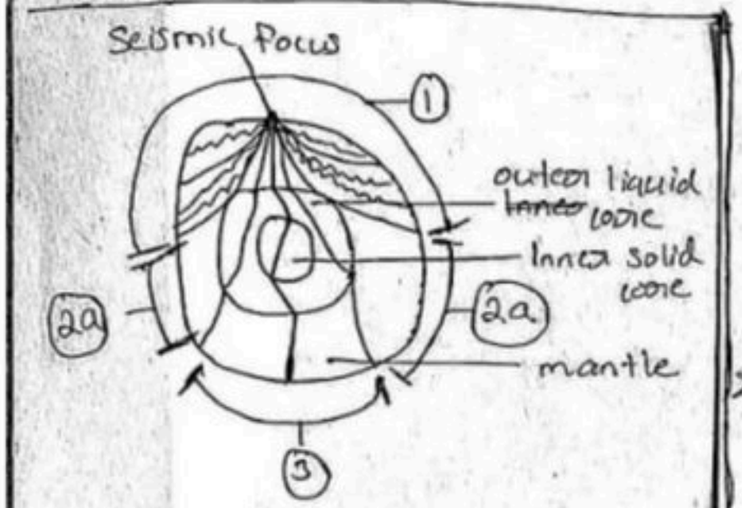
50 W.

QW Bring out the relevence of seismic study in determining the structure of interior of the earth. — ATHUL

AND "The rider (Body waves) ~~was~~ already moved from the starting point (seismic focus) the speed of the ride is depends on the route (P-waves; faster in solid and slower in liquid) change in situation may cause change in route (refraction — due to change in medium) at the end he will be able to talk a lot — that what he saw on ~~the~~ his way"

Earth's internal structure can be understood by analysing the patterns of — ~~reflection~~, refraction and change in velocity of the seismic waves when they travel through it.

Seismic activity is a decisive source of informations about the interior of the earth



1 — both 'S' and 'P' waves felt

2a — Shadow zone — very weak 'P' waves

3 — only 'P' waves felt

With the help of these properties — seismologists have a fair idea about the interior.

* Change in density greatly varies the wave velocity.
  ↓
  by observing the changes in velocity (using seismograph) — the density and composition of the interior can be estimated

* Shadow regions of waves — area where the seismograph records no waves.
  ↓
  2a and 3 are the areas where 'S'-waves are not recording — experiencing sharply.
  ↓
  because of liquid outer core → 'P'-waves passes through all medium while 'S'-waves passes only through solid medium.

* Even though P-waves pass through all mediums, they refract when they enter from one medium to another.
  ↓
  Variations in the direction of waves — are inferred with the help of seismographs → Differences in arrival times, direction and emergence of shadow zones, allow mapping of the Earth's interior

Most of our understanding about the interior of the earth is based on estimates and inferences. It is difficult to collect samples of the material from inside of the earth.

The huge size and the changing nature of the Earth become a barrier for the quest of knowledge —— here is the point where seismic study become a game changer. The best way to prove, what is there inside the earth.

> "Earthquakes traveling through the interior of the globe — are like so many messengers sent out to explore a new land. The messages are constantly coming and seismologists are fast learning to read them."

Thy - Weathering :-

A process in which disintegration & chemical decomposition takes place due to weather & climatic ~~agents~~ factors these factors are water, ice, salt, wind etc. Weathering are of following types -

1. Mechanical weathering → it occurs in dry and humid regions. it also called Physical weathering because in it rock's ~~is~~ physically weathered, ~~(b)~~ Compositionally remains same. following are factor which contribute to physical weathering -

(1) Exfoliation due to ~~therm~~ Temperature and wind -

(2) in which temperature uncover the rock and wind took it away.

(2) Exfoliation due to unloading - upper layer removed.

(3) Thermal expansion and contraction - due to ~~diur~~ diurnal temprature

(4) Granular disintegration -

dark-coloured mineral absorb more heat and disintegrate

⑤ Freezing & Thawing

2 Chemical weathering - it occurs in hot and humid region. in which rocks physically unchanged, but chemically chemical character changed. following are the reasons -

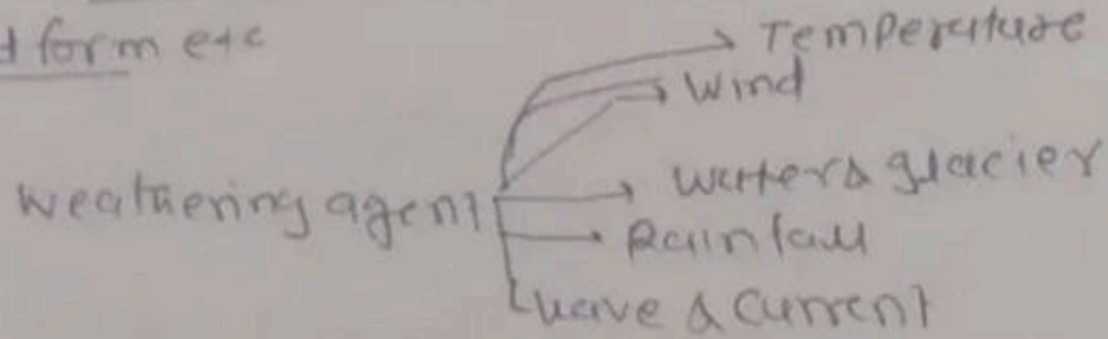
① Solution - Some in contact with water & solid part removed.
② Carbonation
③ Hydration
④ Oxidation / reducting ⑤ Chelation

3. Biological weathering - in it occurs due to flora and fona.

Q.2 Weathering is a complex phenomenon involving a number of process and influenced by various factors." Elaborate

Ans: Weathering is kind of multiple process system just like Photosynthesis is process which play vital role for biotic component in ecosystem. In same way weathering provide fertile soil which is necessary for human life

Weathering is a physical disintegration of molecules or grain from rocks. It is an in-situ or on site process. It is influenced by many factors like weathering agent, Structure of Parent rock, Topography, Relief of land form etc



(1) Physical weathering: Driving force for Physical weathering is →

Force
- → Gravitational force
- → Force/ Energy by temp. expansion & Contraction
- → water pressure by wet & dry Process

(A) exfoliation ~~by~~ of rocks by heat & wind: dry region
→ when rock, experience heating in daytime & Cooling in night time, get weakening of its molecules & exfoliation then wind remove these broken off sediments.

(B) exfoliation and disintegration by unloading
when underlying rock experience unloading due to removal ~~exposure~~ of upper rock by climatic agent. It get exfoliation by less pressure & exposed to weathering Process

(C) Thermal Contraction & expansion:
When temp. rises rock expand & when temp cools rock ~~get~~ get Contraction. This alternate expansion & contraction of rock get weathered

(D) Freezing, melting & Thawing: In higher latitude water accumulate in pores of rock in summer days. ~~in~~ when temp. go down water get freezed & this freezed water expands its volume by 9%. This repeated cycle cause thawing & ultimately rock get weathered

(2) Chemical weathering: This Process dominates in humid region

driving force → chemical action

(A) Solution: many rocks forming minerals like phosphate, Potassium Nitrate get dissolved in water or weak acids. By this Process karst topography is evolved

(B) Carbonation: Sodium carbonate and magnesium carbonate minerals are soluble in weak carbonic acid. They get dissolved & weathering take place

(C) Hydration: when rock's mineral get water & weathered
Like $CaSO_4 + H_2O \xrightarrow{\text{converted}} CaSO_4 \cdot 2H_2O$ [Gypsum]

(D) Oxidation & Reduction: when minerals of rock get O_2 & becomes oxides like red soil under oxidation

when rock exposed to waterlogging or O_2 deficient, it get reduction & convert into bluish colour

(E) Biological weathering: It is not separate process but it help physical and chemical weathering by increasing efficiency of weathering agents.

Driving force → micro flora and fauna

when roots of fauna get disintegration of rock's molecule by penetrating i.t. finally rock exposure to wheathering agent. It also done by fauna

mother earth is providing basic services to human life by many approaches/system. Lets have adopt one system in which we should not act as catalyst to disturb the natural cycle of atmosphere

Hanismegh

Please Write Your

