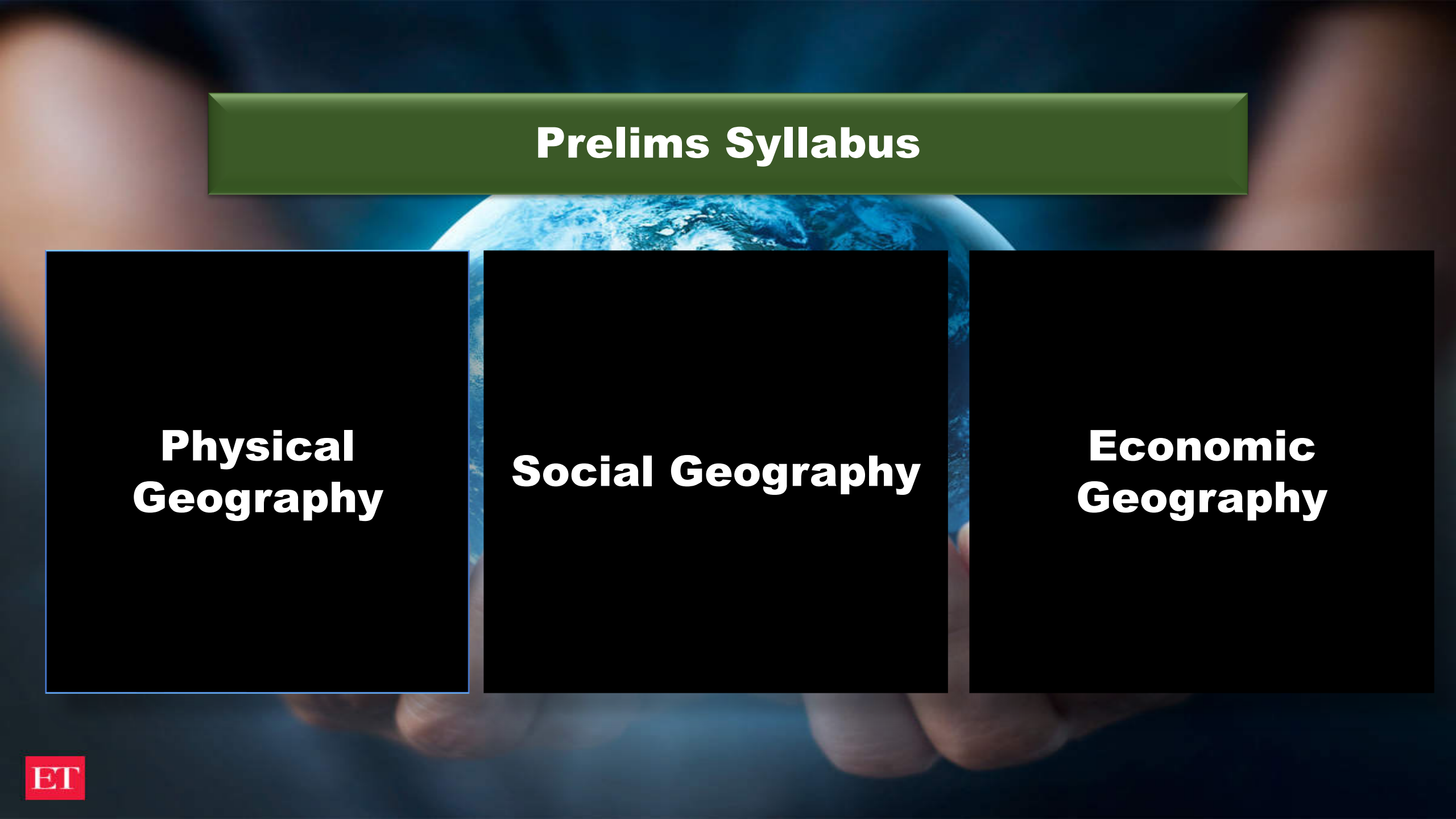


The background of the slide features a close-up of a person's hand holding a small, transparent globe of the Earth. The hand is positioned at the bottom, with fingers visible, and the globe is held between the thumb and index finger. The globe shows blue oceans and white clouds. The overall lighting is soft, with a blueish tint.

Prelims Syllabus

**Physical
Geography**

Social Geography

**Economic
Geography**

SYLLABUS – MAINS

1. Salient features of

WORLD'S PHYSICAL GEOGRAPHY.

2. Distribution of key ***NATURAL RESOURCES*** across the world. Factors responsible for the location of primary, secondary, and tertiary sector ***INDUSTRIES*** in various parts of the world

3. Important ***GEOPHYSICAL PHENOMENA*** such as Earthquakes, Tsunami, Volcanic activity, Cyclone etc. ***GEOGRAPHICAL FEATURES*** and their ***LOCATION – CHANGES*** in critical geographical features and in flora and fauna and the ***EFFECTS*** of such changes.

Sources for Geography

Prelims and Mains

- **NCERT- World Physical Geography- Class XI**
- **NCERT- India Physical Environment- Class XI**
- **NCERT- Fundamentals of Human Geography- Class XI**
- **NCERT- India People and Economy-Class XII**
- **Oxford School Atlas- Latest Edition (36th Edition)**
- **Indian and World Geography, Majid Husain**

Prioritizing ACS Study Plan

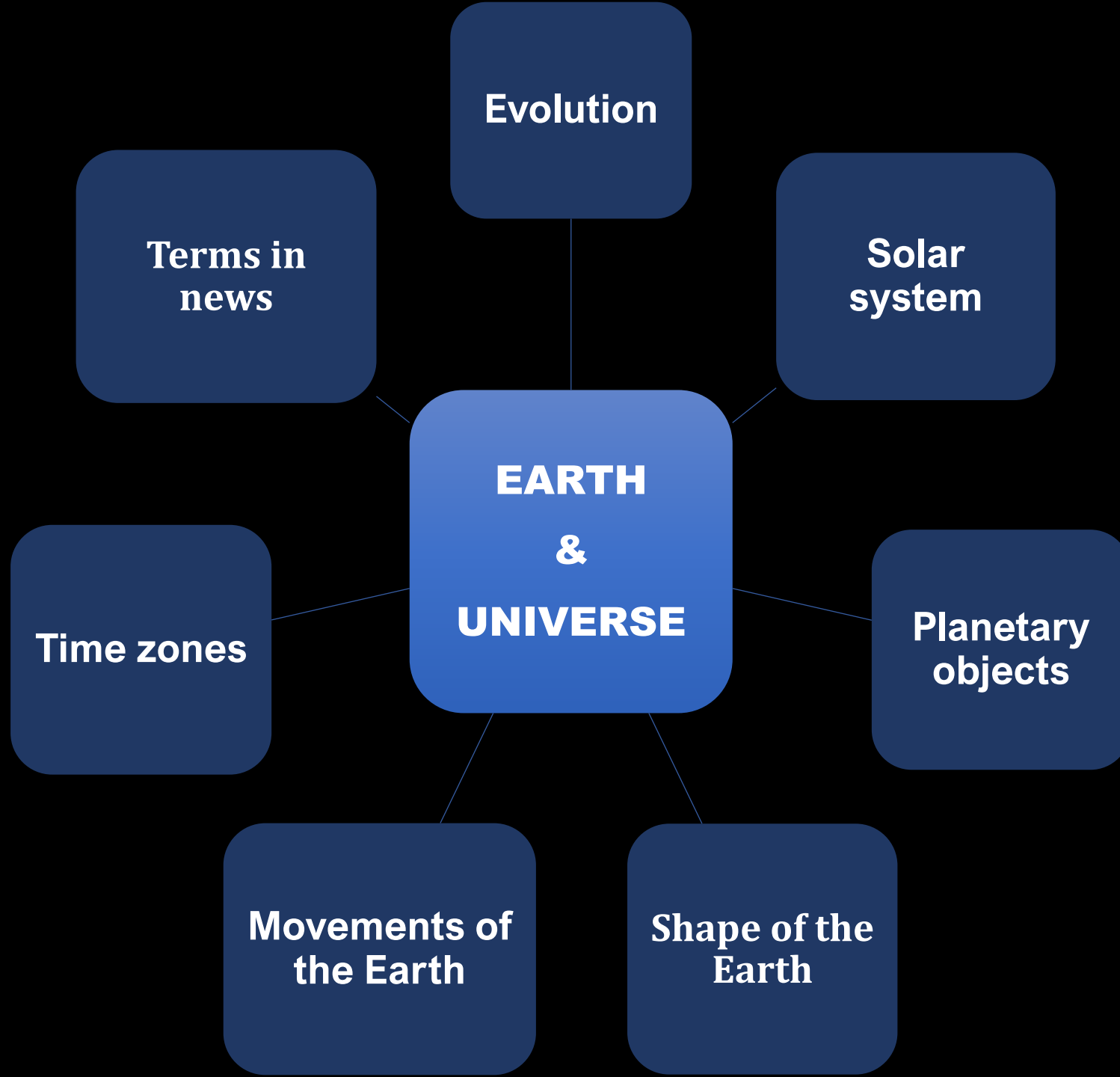
Understand and relate with surrounding

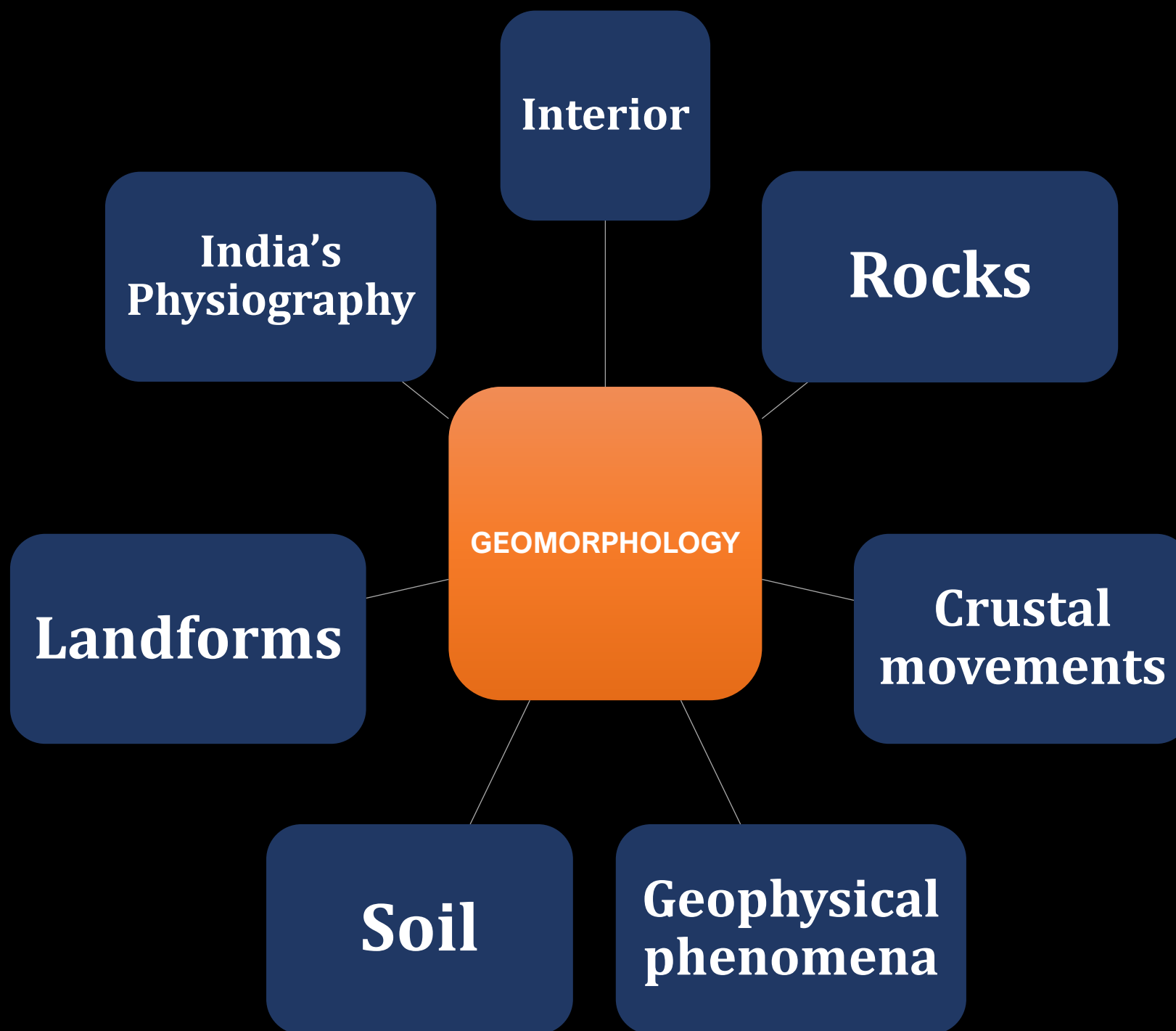
Solving questions

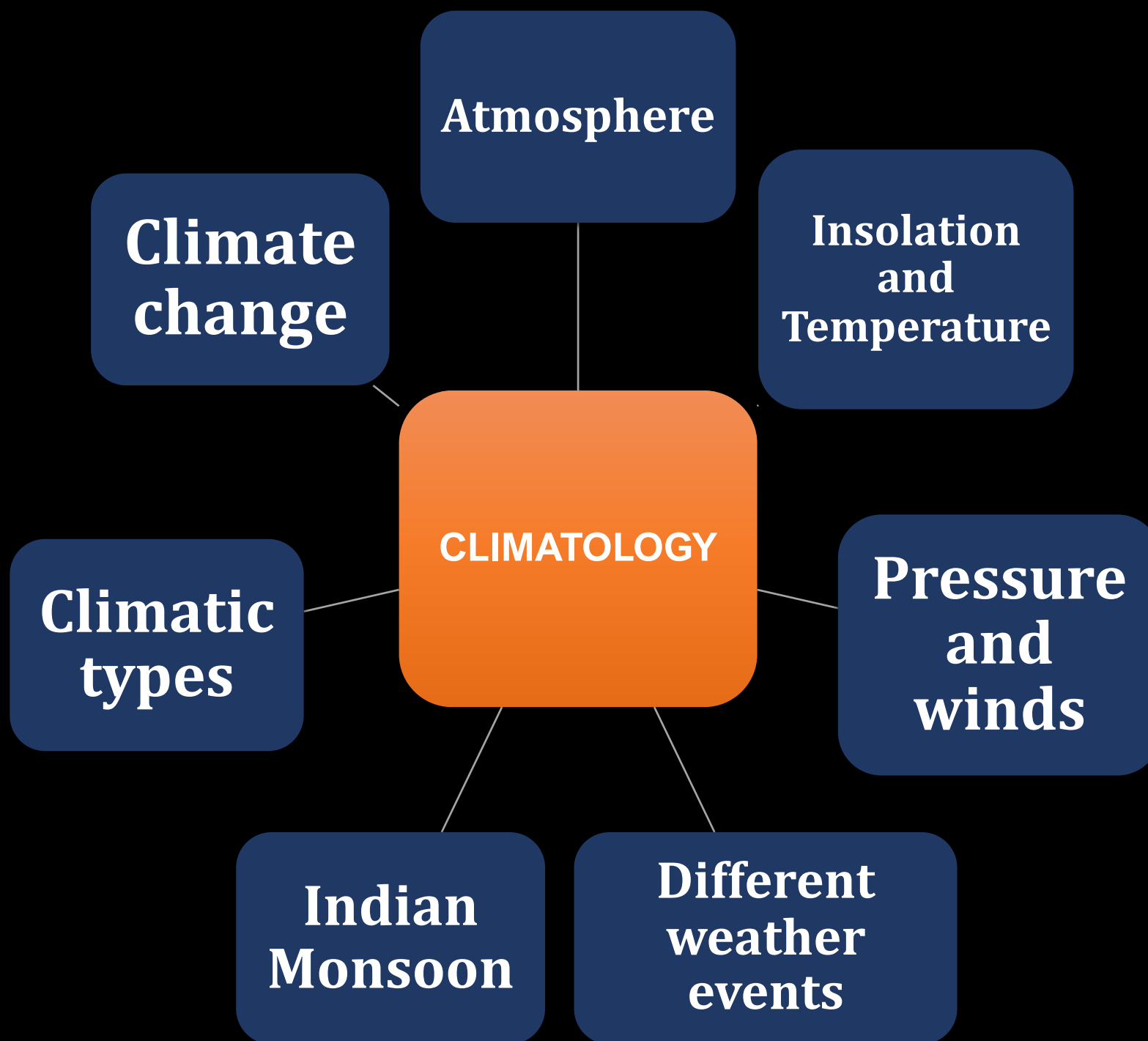
Facts to memorize with concept

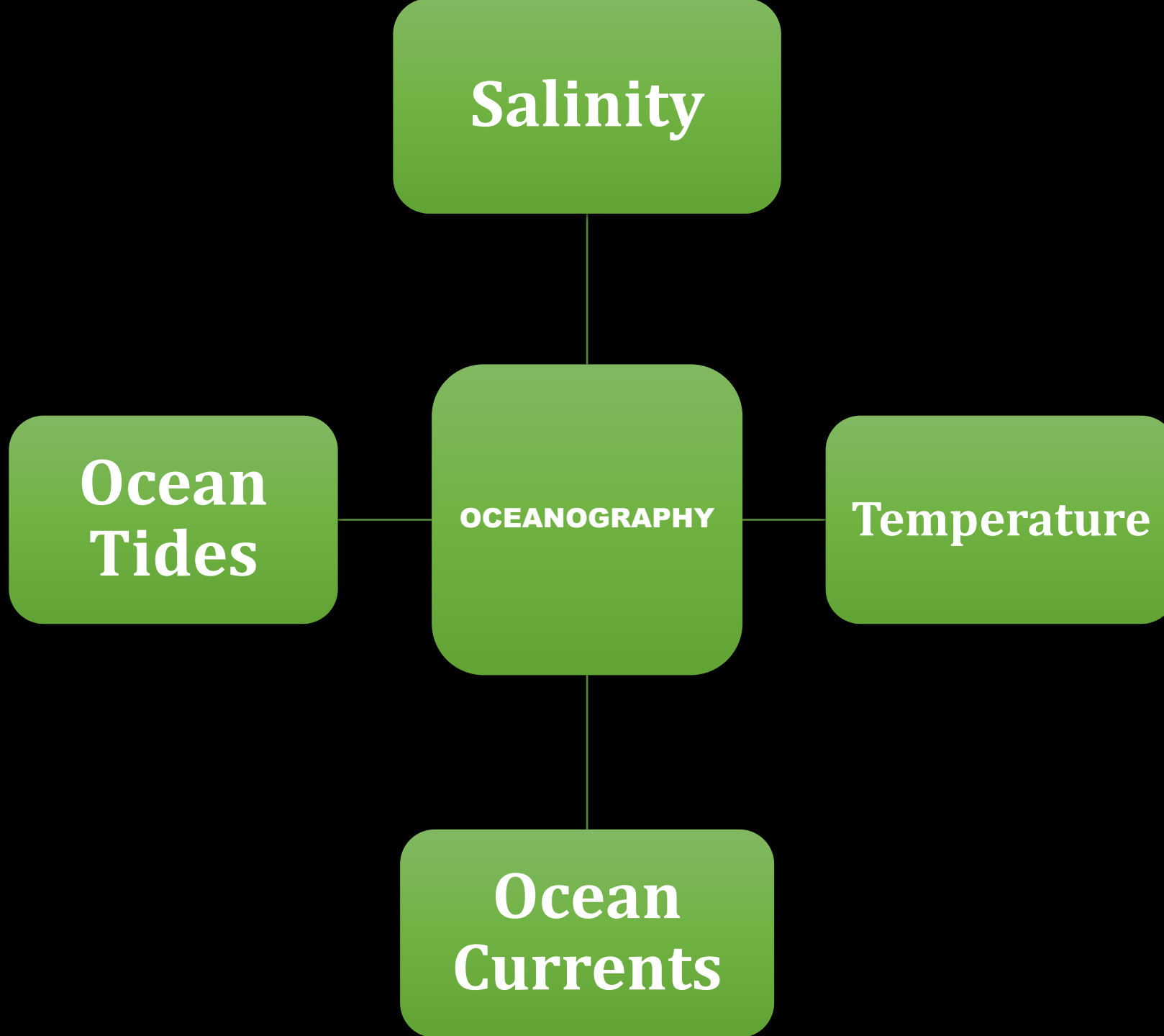
Repeated revision

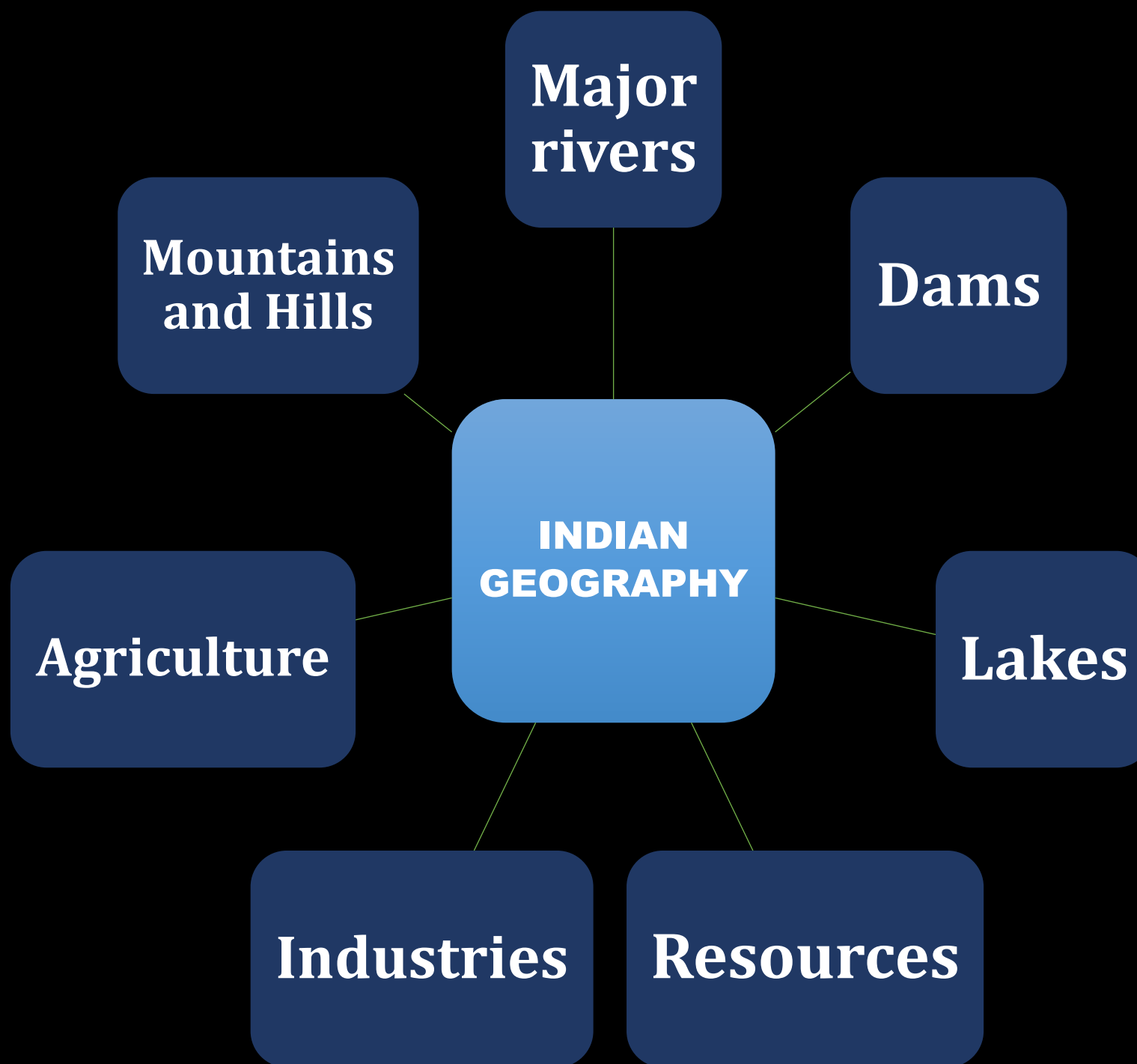
Short-notes











EARTH & UNIVERSE

PHYSICAL
GEOGRAPHY

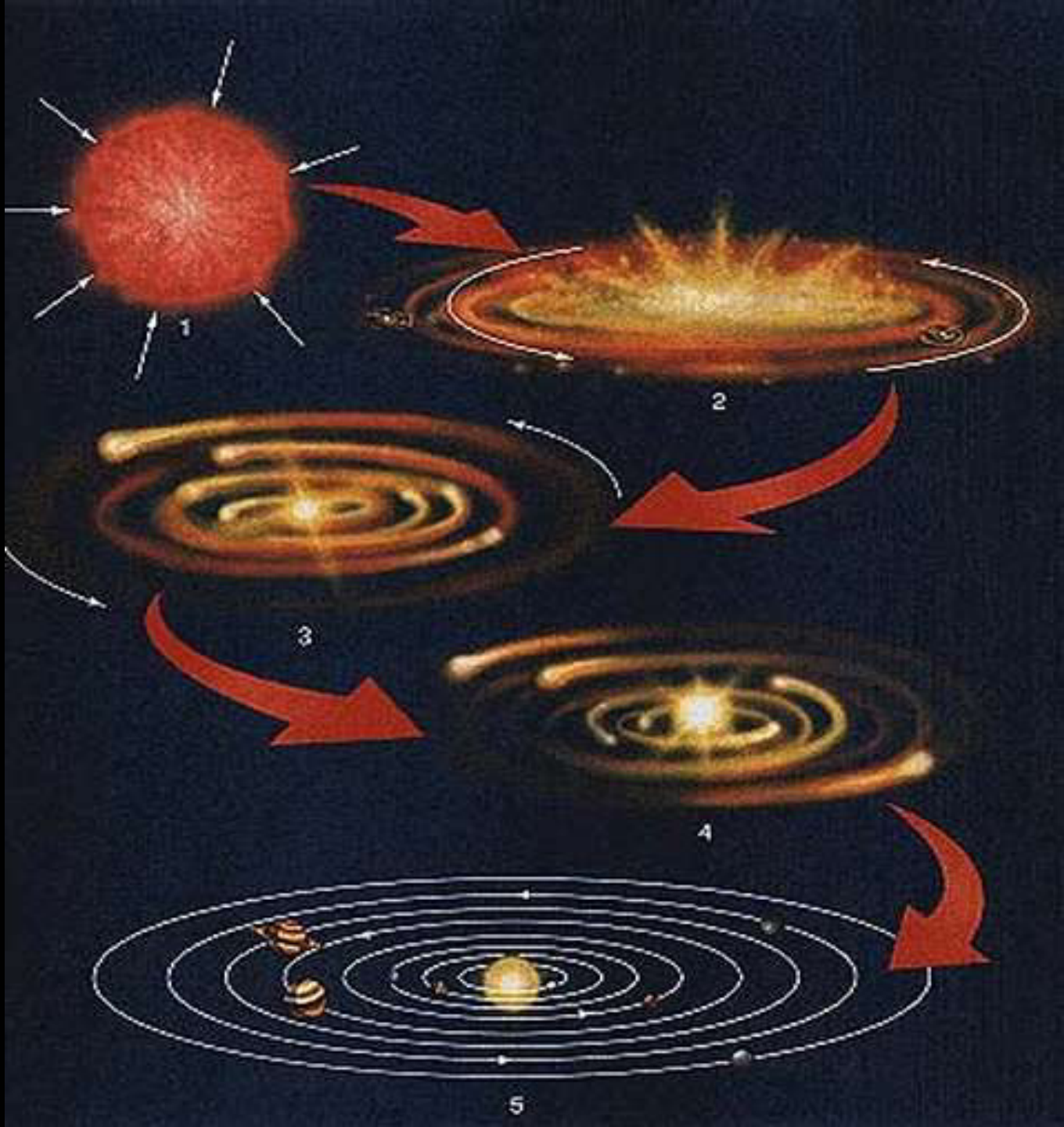


The Nebular Hypothesis

Marquis Laplace in 1796

Failed to explain
distribution of Angular
Momentum

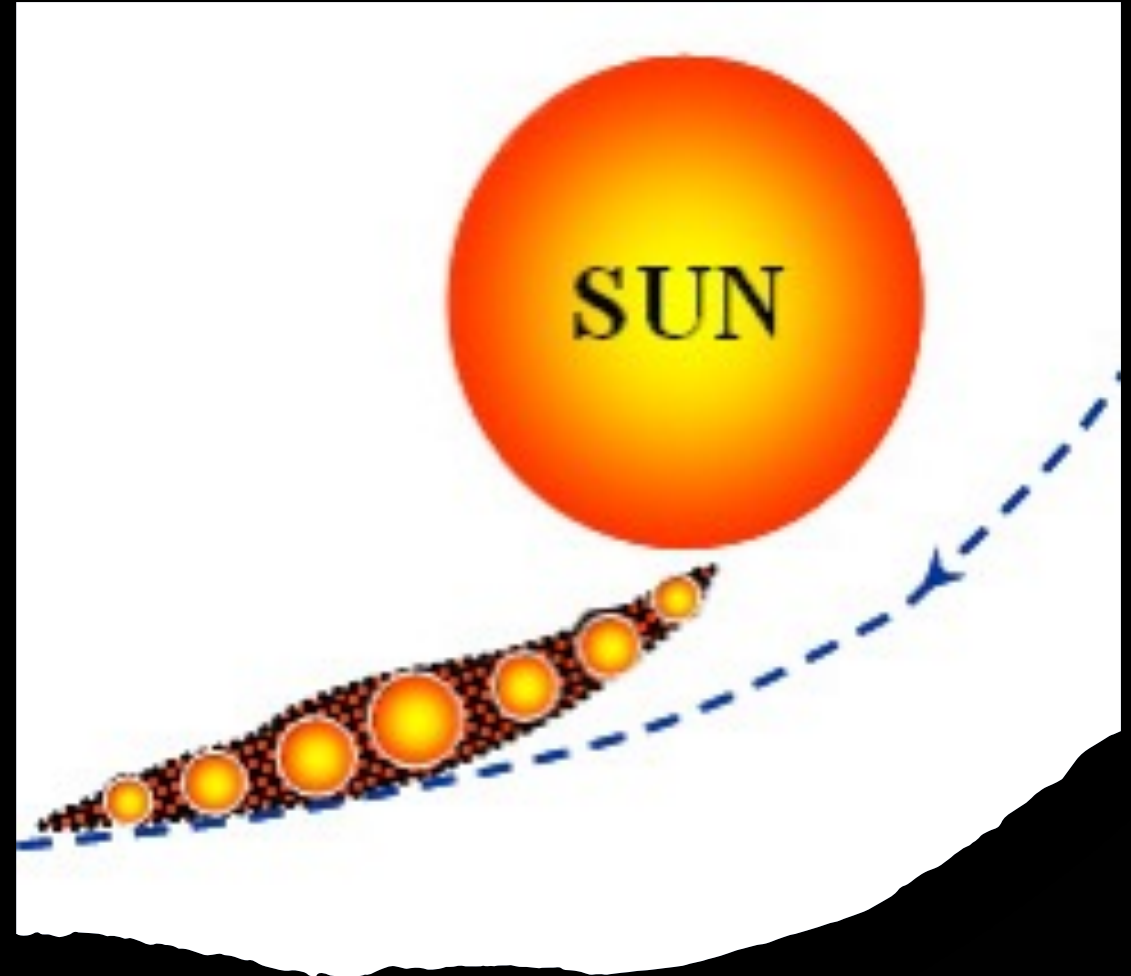
Reasons for differentiation
of size and mass of
planetary bodies



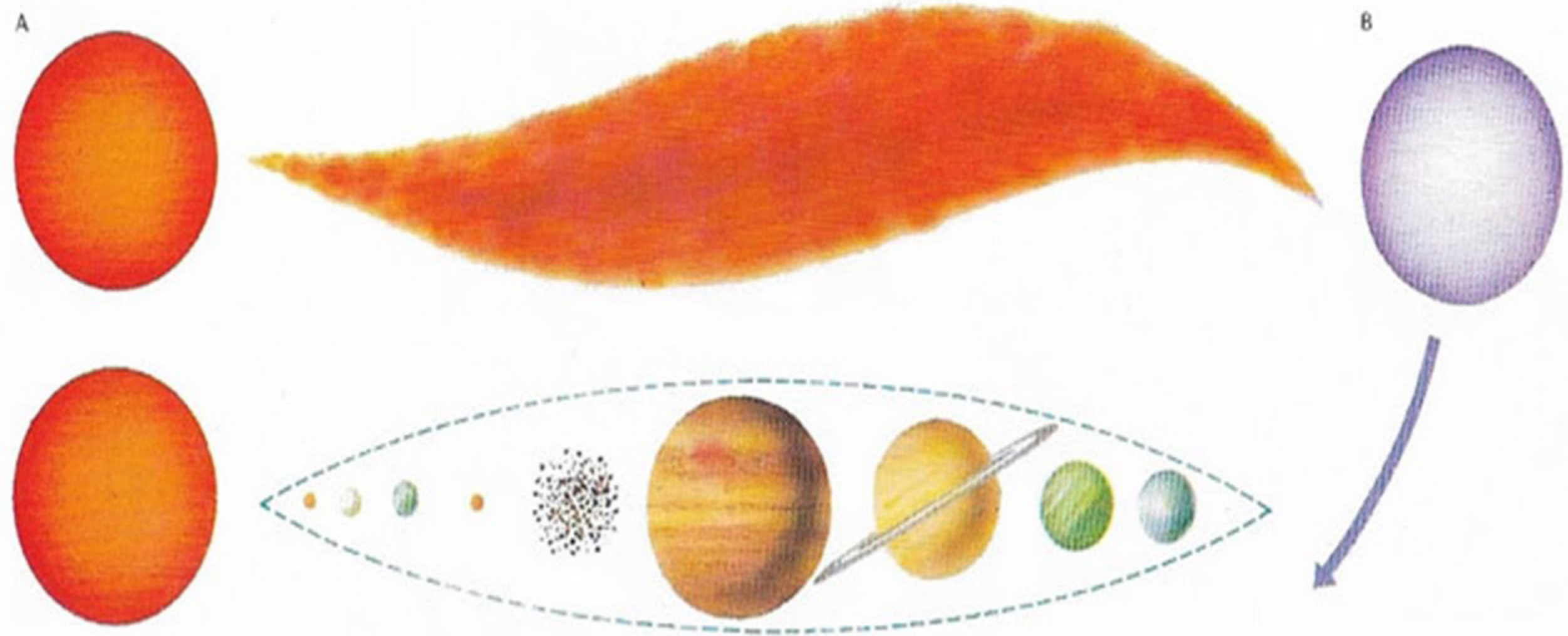
The Planetesimal Hypothesis

Chamberlin & Moulton in 1904)

- The greatest flaw in the theory is the assumption that the material drawn out of the stars would condense.
- Before condensation could take place, the gases would have almost entirely disappear.



Tidal Hypothesis of James Jeans



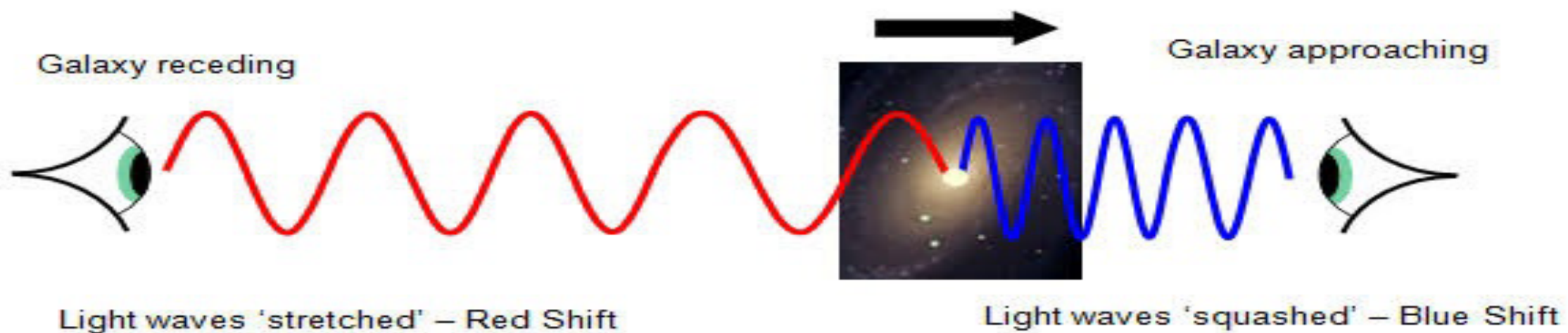
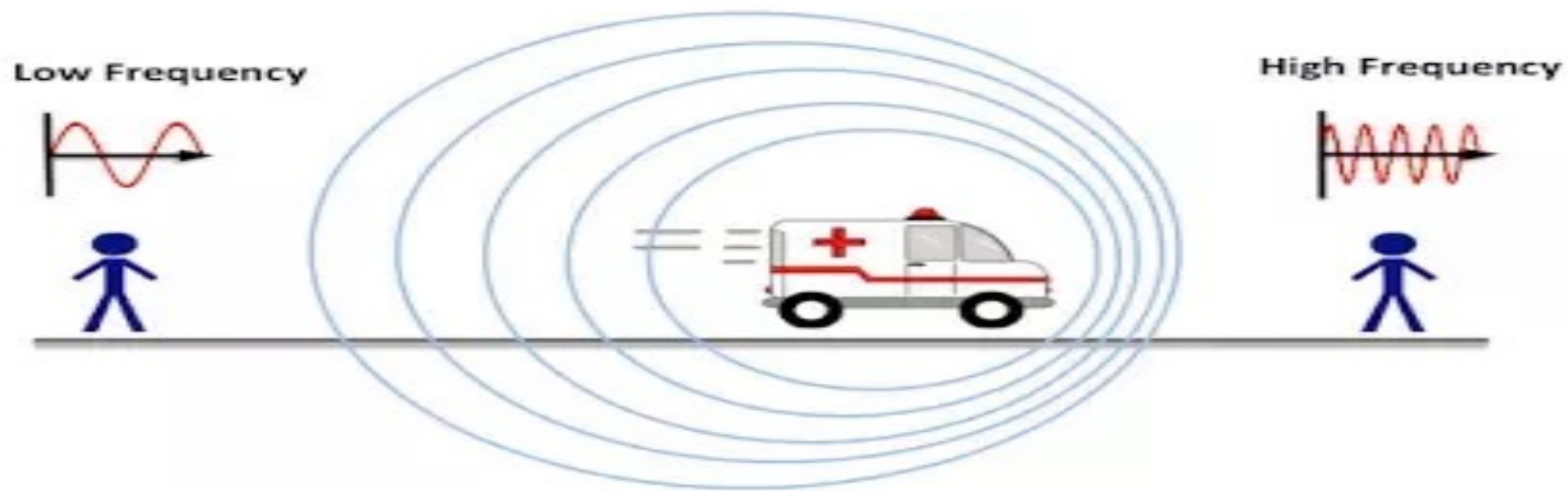
1. The Gaseous Hypothesis of Immanuel Kant in 1755
2. The Nebular Hypothesis of Marquis Laplace in 1796
3. Alfven's Electromagnetic Theory of Hannes Alfven in 1942
4. Planetesimal Hypothesis of Chamberlin & Moulton in 1904
5. The Tidal theory of Sir James Jeans & Sir Harold Jeffreys in 1919 & 1926
6. The Binary Star Hypothesis of H N Russell
7. The Nova Hypothesis of F Hoyle in 1939
8. The Interstellar Dust Hypothesis of Otto Schimdt
9. The Protoplanet Hypothesis of Gerald Kuiper in 1951

The Big Bang Theory

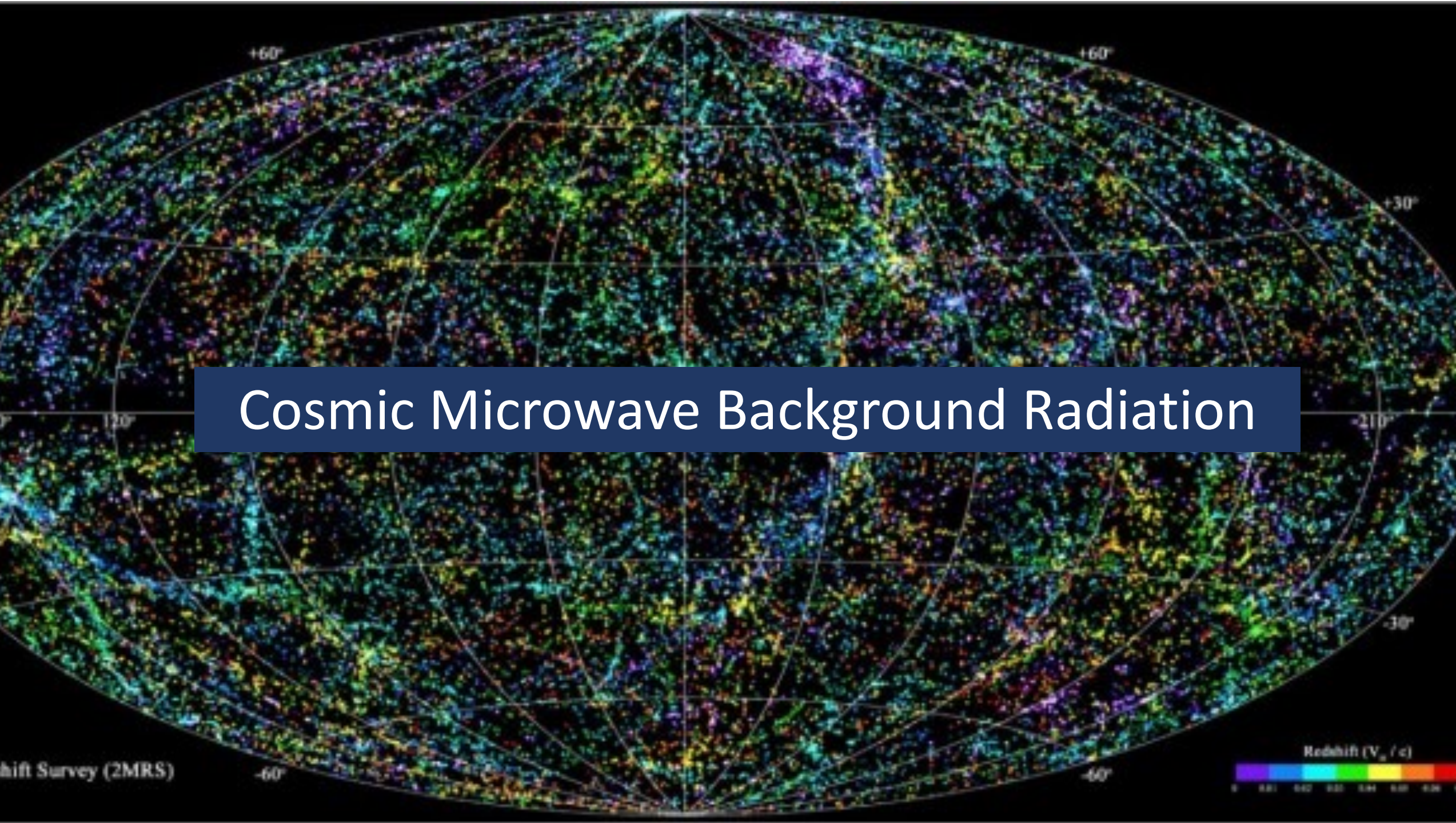


- 1. The Big Bang Explosion took place 13.7 billion years ago**
- 2. Matter and Energy were released from the expansion**
- 3. Helium & Hydrogen were the first elements to be formed by recombination of particles after cooling down of the Universe.**
- 4. Gradually, the Galaxies or Milky way was formed by the clusters of atoms and inside the Galaxies the stars were originated.**
- 5. These stars released a ripple/wave effect and helped form almost all the remaining elements of the Universe.**
- 6. Those elements were like the building materials of Planets, Moons, Life and everything in the eco system.**
- 7. The Big Bang Theory was first suggested by Edwin Hubble in 1920.**

Doppler Effect



Cosmic Microwave Background Radiation



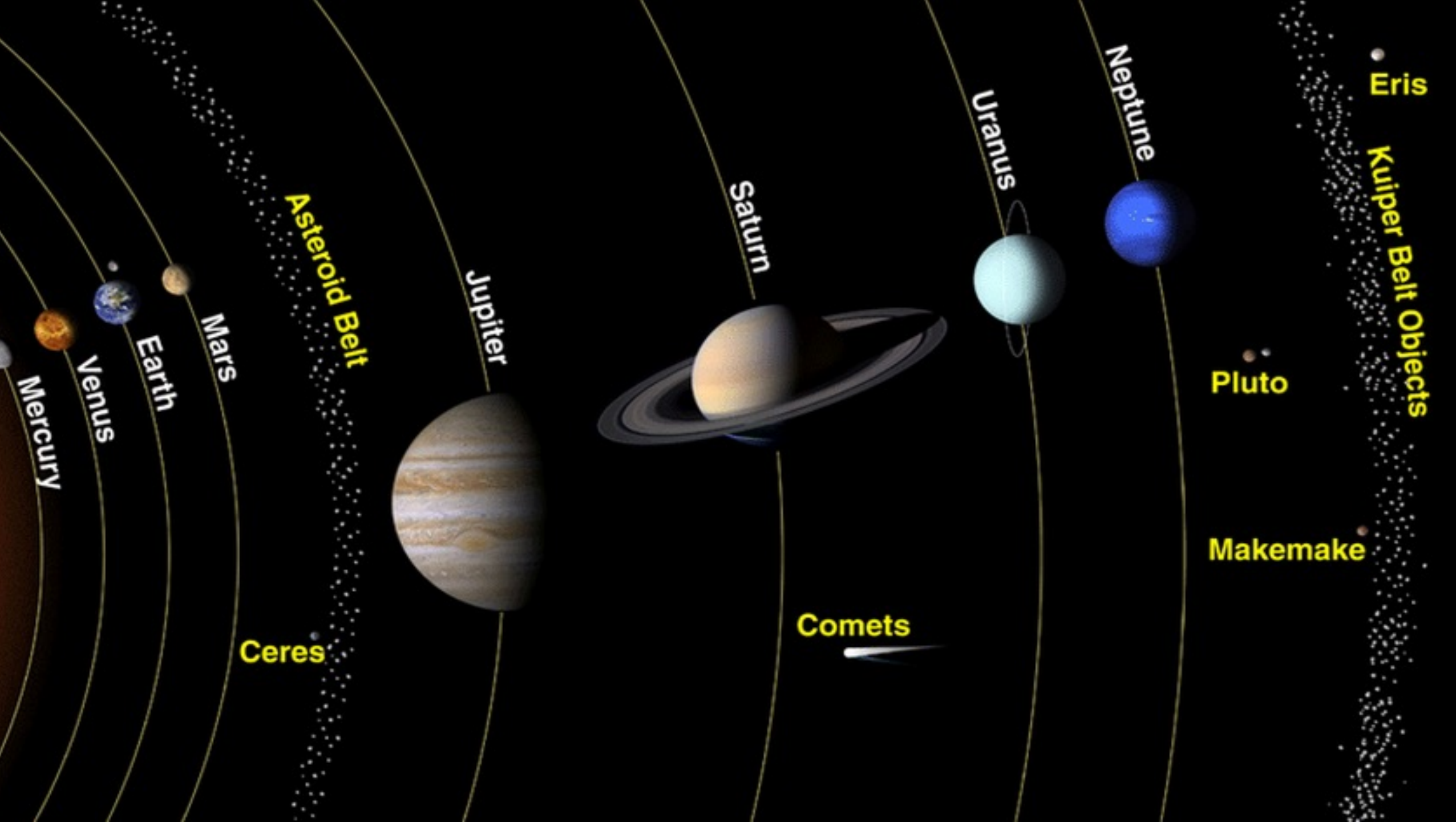
Previous Year 2 (2012)

Which of the following is/are cited by the scientists as evidence/evidences for the continued expansion of universe?

- I. Detection of microwaves in space**
- II. Observation of red shift phenomenon in space**
- III. Movement of asteroids in space**
- IV. Occurrence of supernova explosions in space**

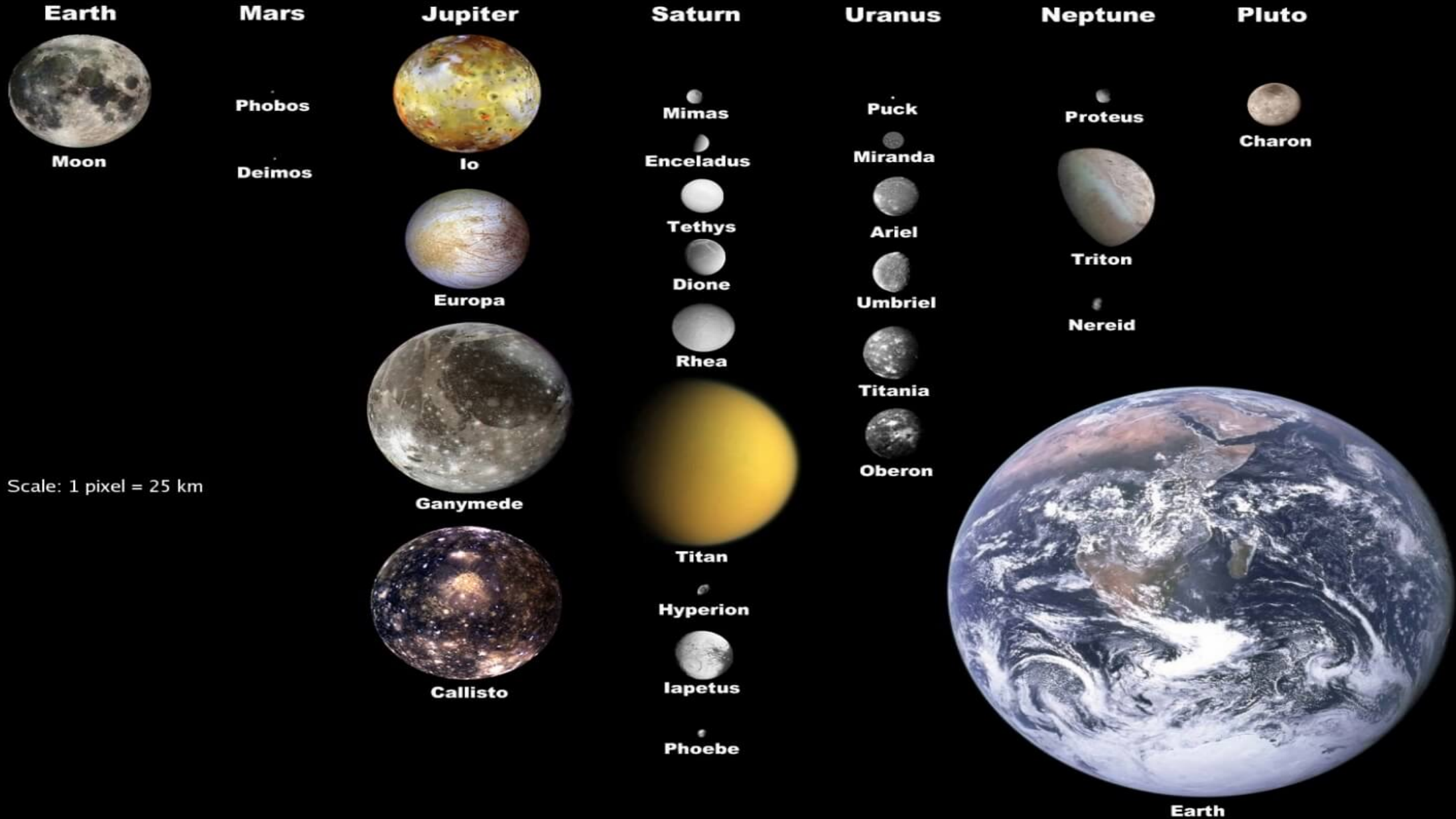
Select the correct answer using the codes given below:

- a. I and II**
- b. II only**
- c. I, III and IV**
- d. None of the above can be cited as evidence**



Sl. No.	Planets	Distance from Sun (million kms)	Orbital Period (Earth Days)	Atmosphere	Moons
1. 1	Mercury	58	88 Days		No Moon
1. 2	Venus	108	225 Days	Carbon Dioxide	No Moon
1. 3	Earth	150	365.25 Days	Nitrogen, Oxygen, and other gases (Argon, Carbon dioxide ,Neon etc).	1
1. 4	Mars	228	687 Days	Carbon Dioxide, Nitrogen, and Argon gases	2
1. 5	Jupiter	778	4,333 Days	Hydrogen and Helium gas	53
1. 6	Saturn	1427	10,759 Days	Hydrogen and Helium gas with traces of other substances(Methane & Water ice)	53
1. 7	Uranus	2870	30,687 Days	Hydrogen and Helium, with a small amount of Methane, traces of Water and Ammonia	27
1. 8	Neptune	4497	60,190 Days	Hydrogen and Helium with just a little bit of Methane	14

Selected Moons of the Solar System, with Earth for Scale



Europa

- sixth-closest to the planet of all the 80 known moons of Jupiter. sixth-largest moon in the Solar System.
- very thin oxygen atmosphere. contains twice the amount of the water in all of the Earth's oceans.
- NASA is expected to launch its Europa Clipper in 2024
- The shallow water pockets beneath the double ridge, like surfaces seen on the Greenland ice sheet on Earth and those seen on Europa's ice shell, increase the potential habitability of the moon.



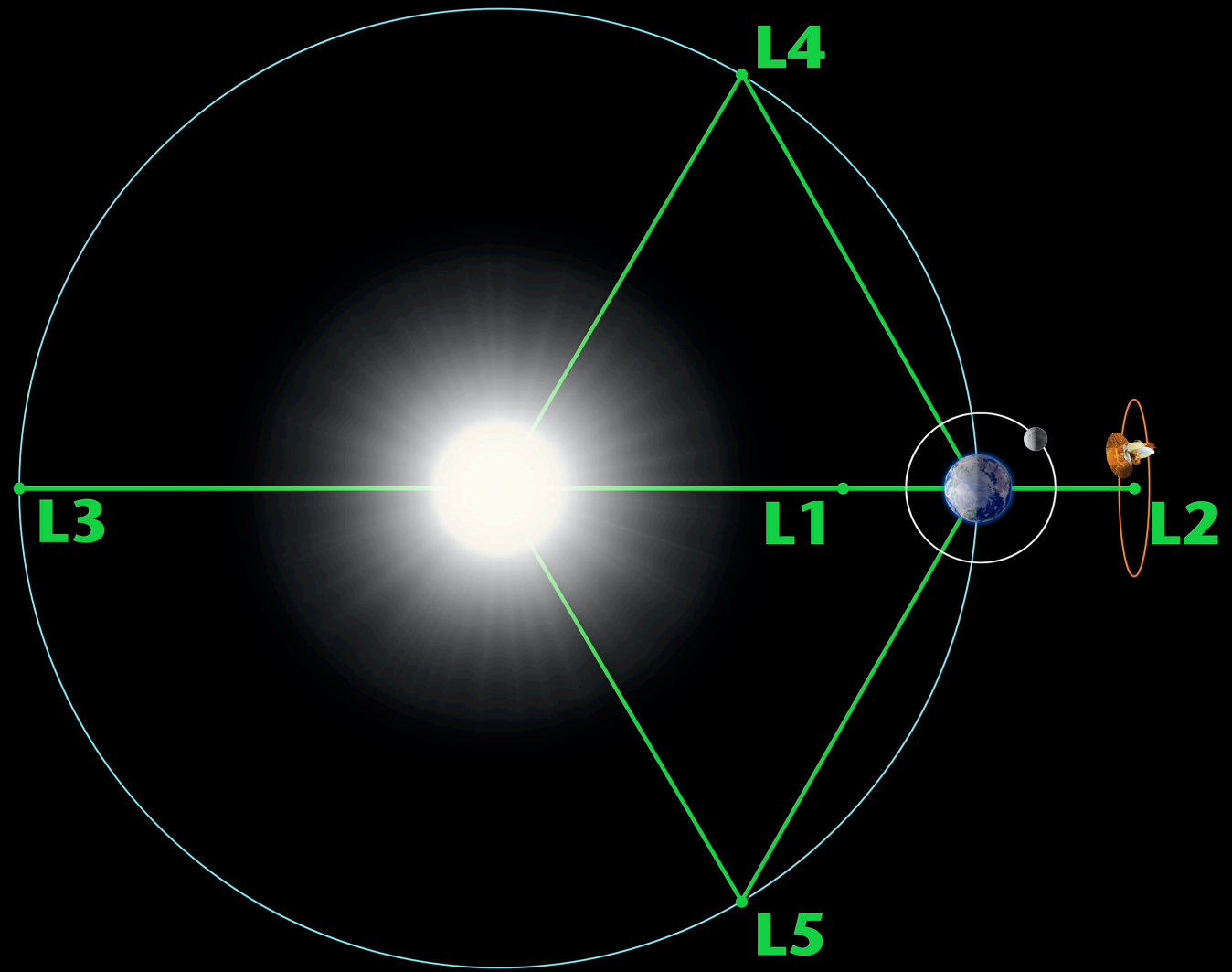
Aditya-L1

- Aditya-L1 is the **first space-based observatory class Indian-space mission** to study the Sun. A satellite placed in the halo orbit around the **L1 point** has the major advantage' of **continuously viewing the Sun without any occultation/eclipse**.
- The suit of Aditya-L1 payloads is expected to provide the **most crucial information to understand the problems of coronal heating, Coronal Mass Ejection, pre-flare and flare activities, and their characteristics**.

Chandrayaan 03:

1. First country to reach lunar south pole.
2. Fourth country globally to reach moon.
23 August is declared as the National Space Day celebrating Chandrayaan 3 landing.
3. The Laser-Induced Breakdown Spectroscope (LIBS) instrument onboard the Rover Pragyan unambiguously confirms the presence of Sulphur (S) in the lunar surface near the south pole.

- **L1, L2 and L3** lie along the line connecting the two large masses.
- Meanwhile, L4 and L5 form the apex
- The **L2**, where the **James Webb Space Telescope** is going, is ideal for astronomy.



Space infrastructure in country:

1. Vikram Sarabhai Space Centre (VSSC),

Thiruvananthapuram, is responsible for the design and development of launch vehicle technology.

2. U R Rao Satellite Centre (URSC) URSC, Bengaluru,

is the lead centre for design, development, and the realization of communication, navigation, remote sensing, scientific, and small satellite missions.

3. Satish Dhawan Space Centre (SDSC), the 'Spaceport of India,' is the backbone of the ISRO in providing launch base infrastructure for the Indian Space Programme.

4. Liquid Propulsion Systems Centre (LPSC) is the lead centre of ISRO for the design, development, and realization of advanced propulsion systems for launch vehicles and space propulsion systems for spacecrafts.

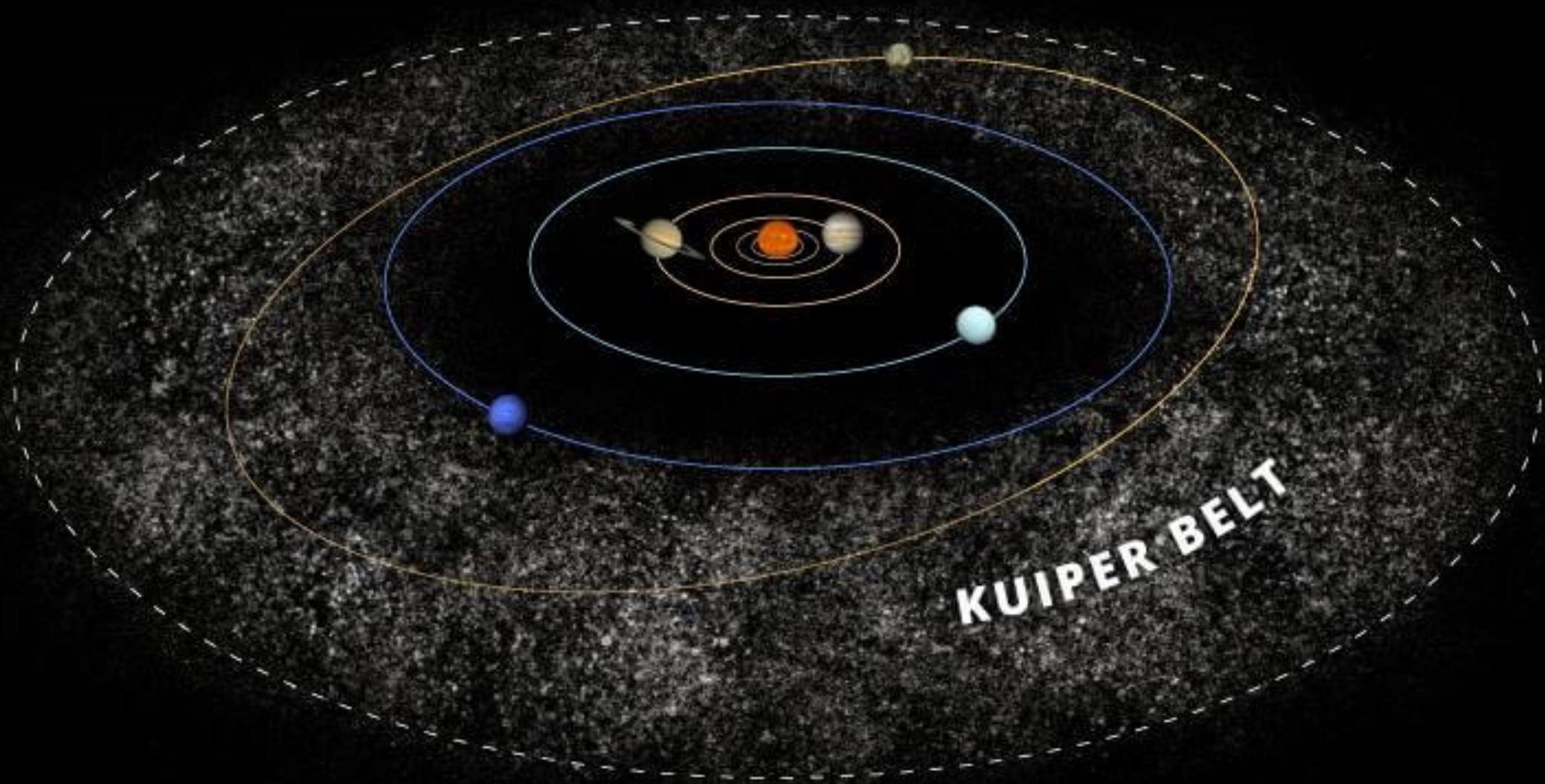
5. Space Applications Centre (SAC) Ahmedabad, is a major research and development centre of ISRO. The core competence of the Centre lies in the development of space-borne and air-borne instruments and payloads.

6. Human Space Flight Centre (HSFC) was formed in 2019 as a lead centre for human space flight activities. HSFC undertakes multi-disciplinary R&D activities in new domains of human science and technology while conforming to **high standards of reliability and human safety.**

7. Antrix Corporation Limited (ACL) with its corporate office in Bengaluru is a wholly owned Government of India company under the administrative control of DOS. Antrix is engaged in **providing space sector products and services worldwide** ranging from supply of hardware and software, earth observation and scientific missions.

8. Indian National Space Promotion and Authorization Centre (IN-SPACe)

As the space sector was opened to private enterprises and startups to undertake space activities to promote, handhold, regulate, and authorize their activities, an independent nodal agency under DOS, the Indian National Space Promotion and Authorization Centre (IN-SPACe) was formed.





Canis Major Dwarf.

Expected Question 2

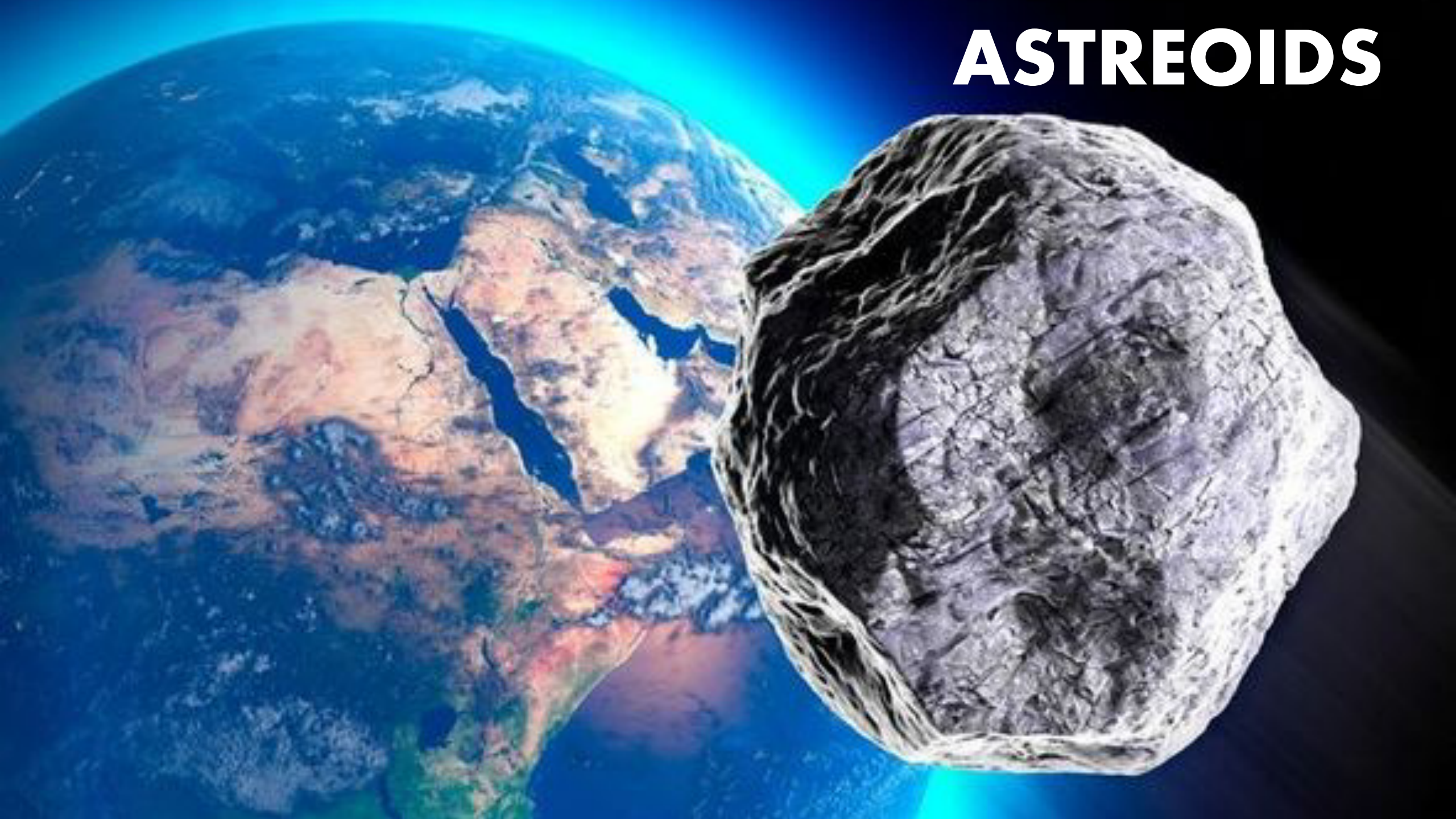
Read the following statements:

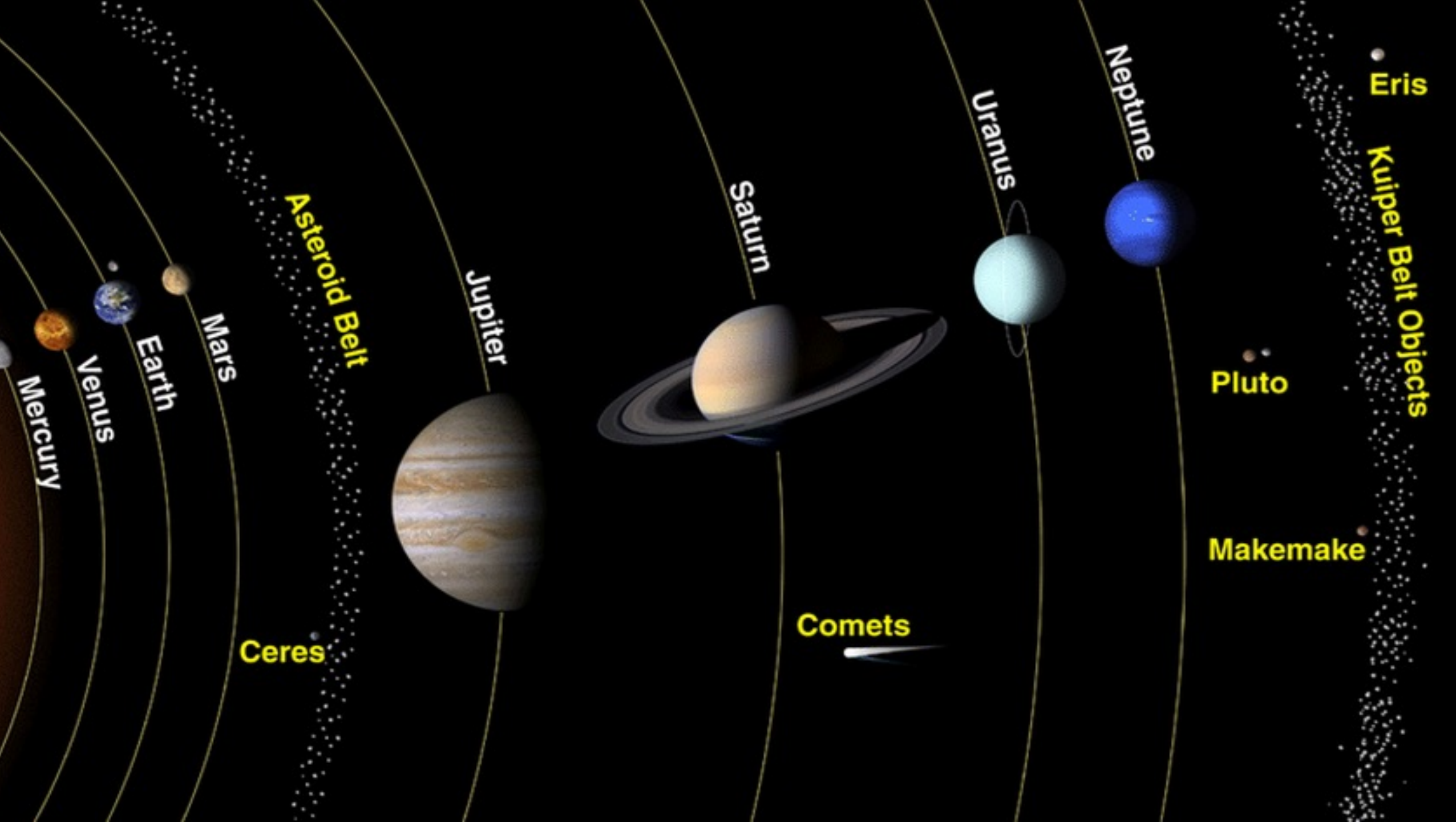
- I. Spiral Galaxies are large rotating disks of stars and nebulae, surrounded by a shell of dark matter.**
- II. Spiral Galaxy is a type of Irregular Galaxies.**
- III. The Milky Way Galaxy is an irregular Galaxy.**

Choose the correct statement(s) using the codes given below:

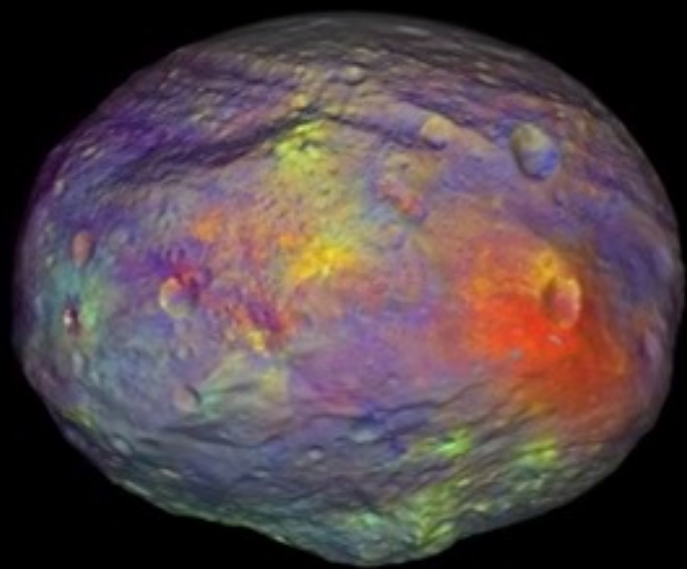
- a. I Only**
- b. II Only**
- c. III Only**
- d. All of the above.**

ASTEROIDS



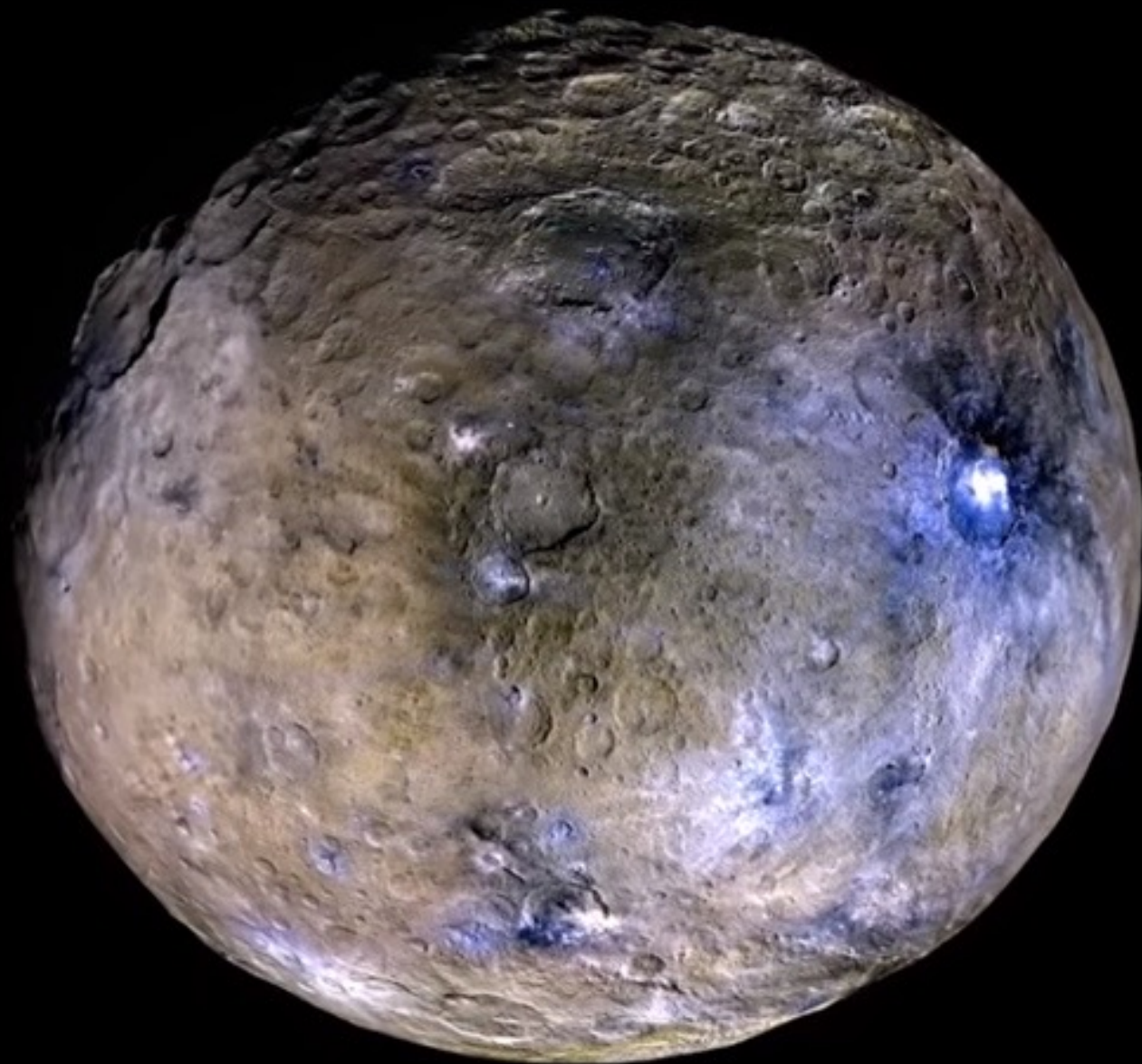


Enhanced color highlights mineral variations



Vesta

Credit: NASA / JPL-Caltech / MPS / DLR / IDA / PSI



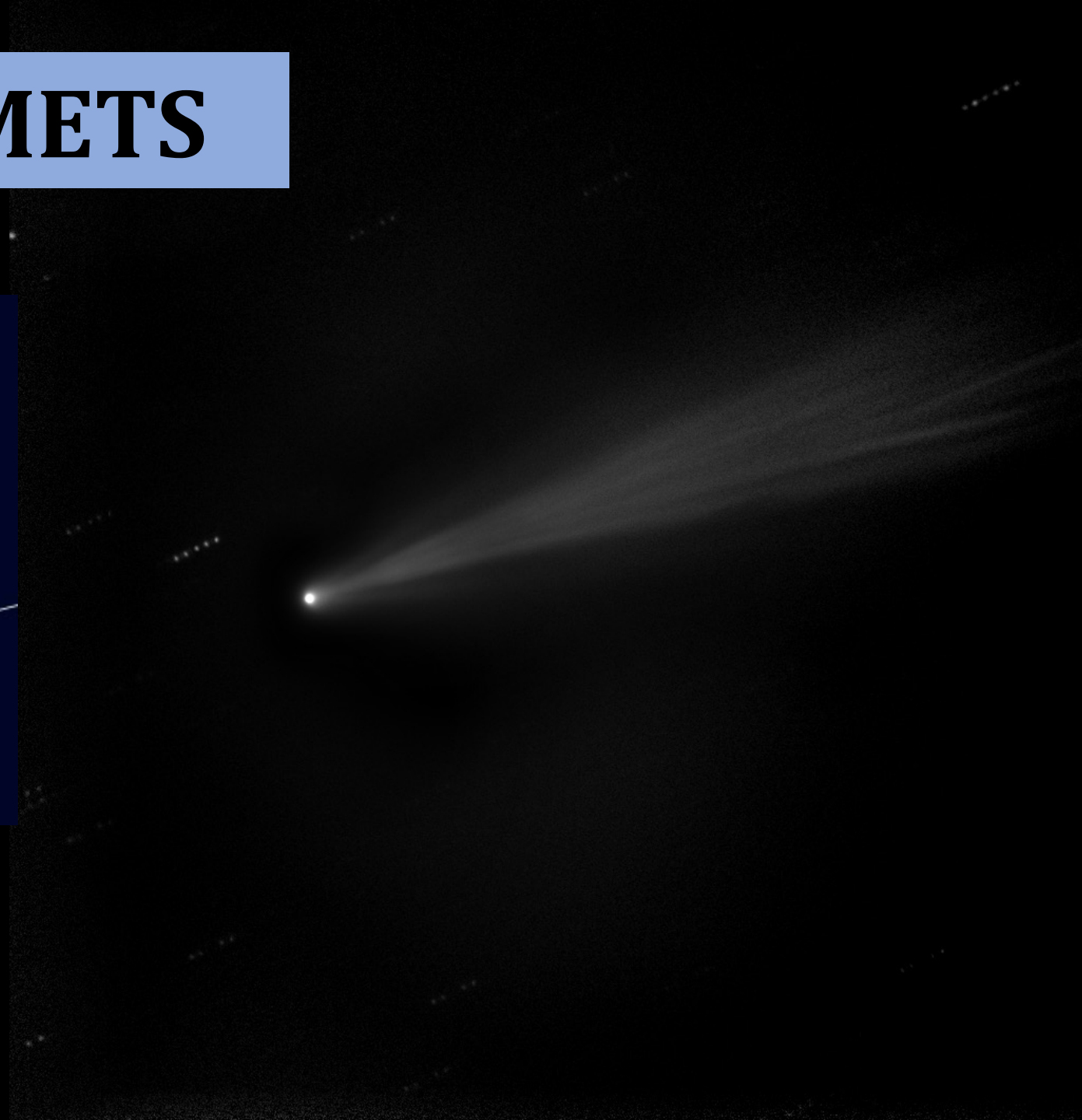
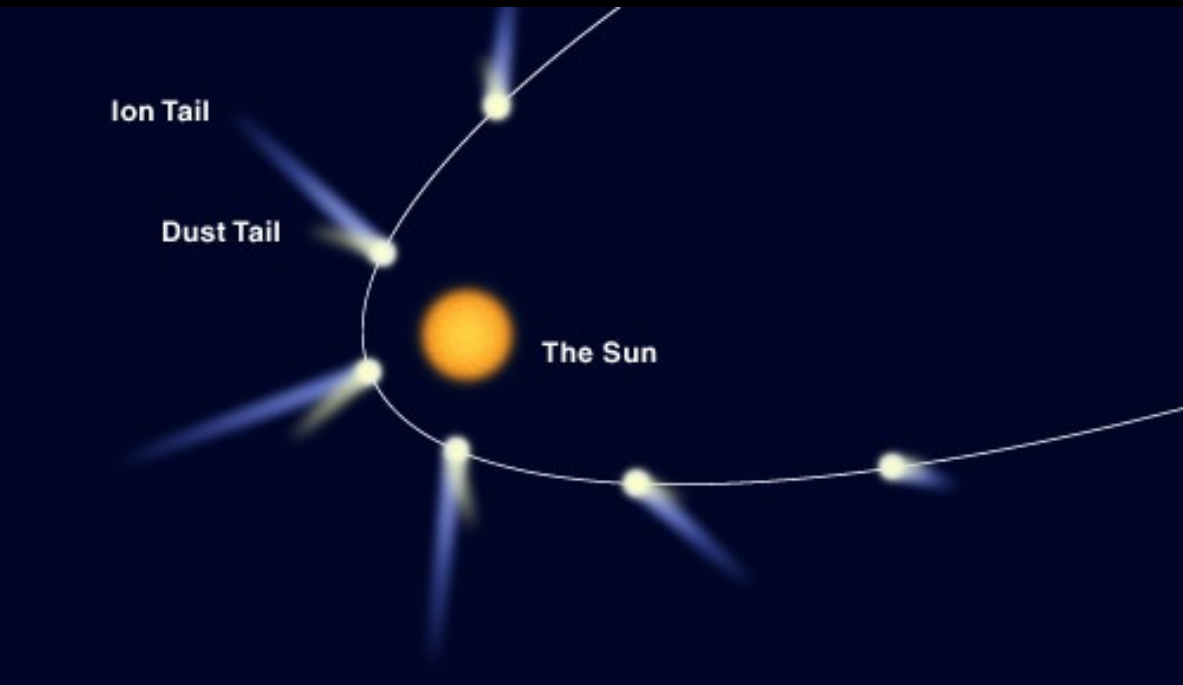
Ceres

Credit: NASA / JPL-Caltech / UCLA / MPS / DLR / IDA

COMETS



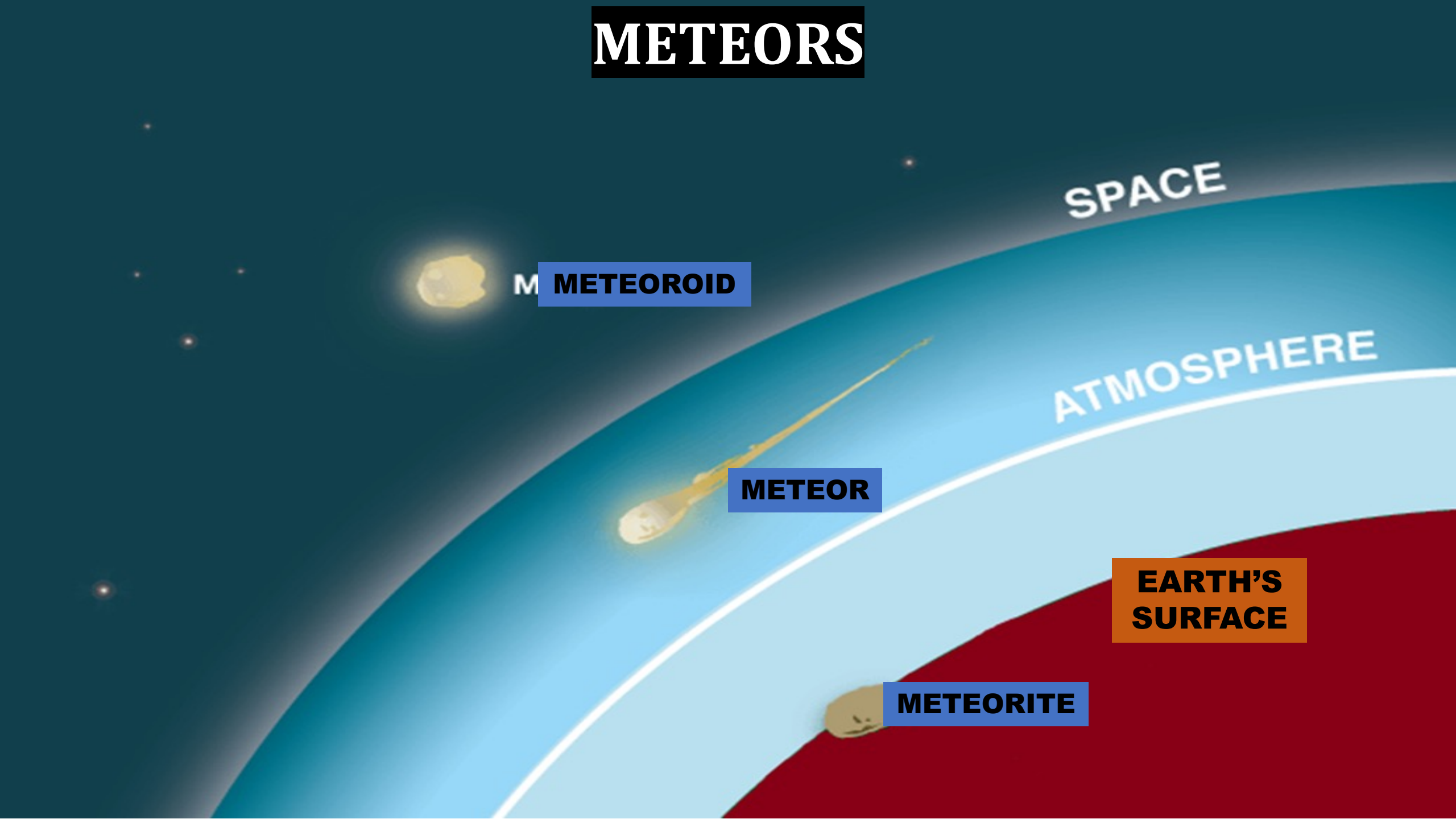
COMETS





Meteor,
Meteoroid,
and
Meteorite?

METEORS



METEOROID

METEOR

METEORITE

EARTH'S
SURFACE

Previous Year (2011)

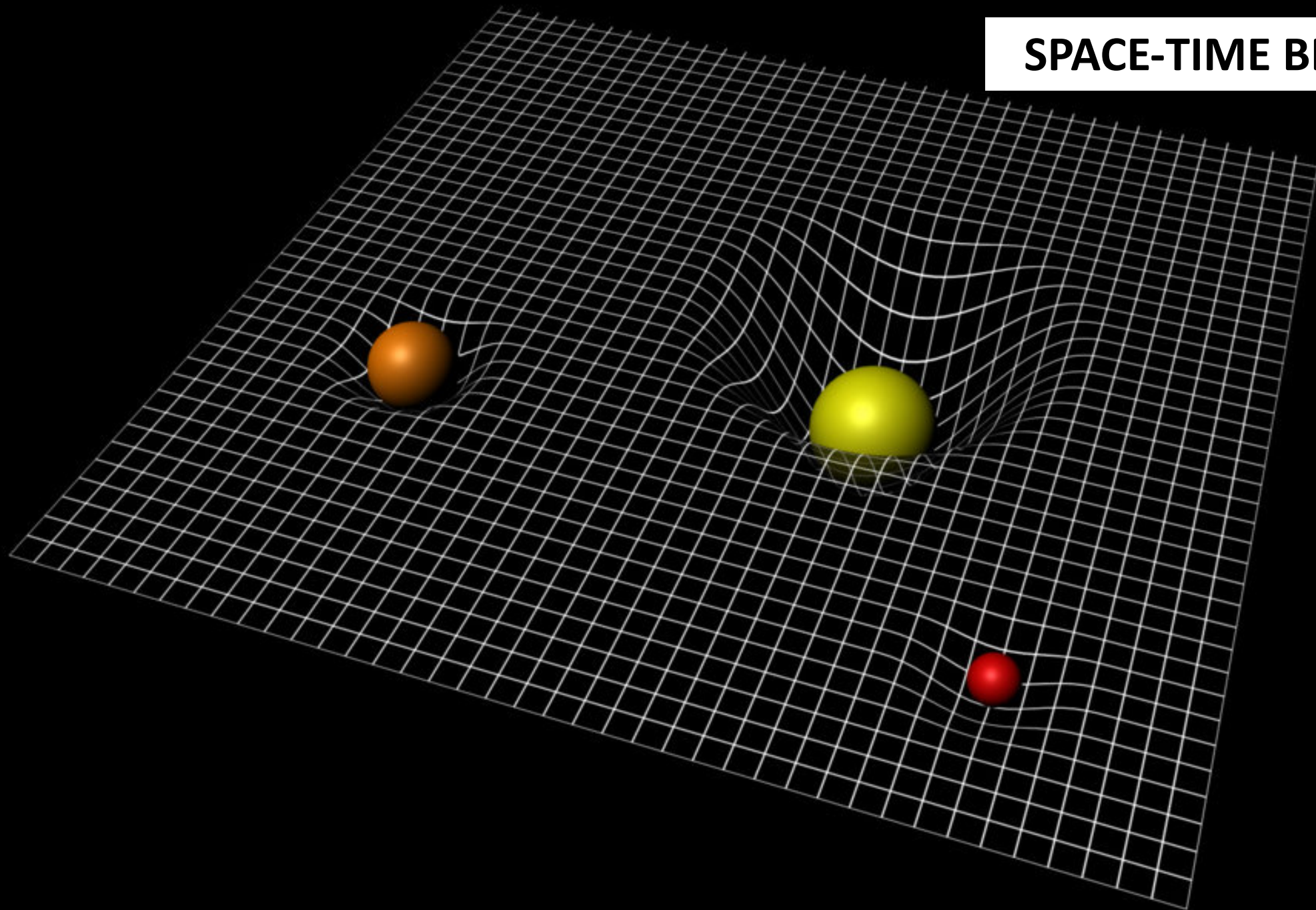
What is the difference between asteroids and comets?

- I. Asteroids are small rocky planetoids, while comets are formed of frozen gases held together by rocky and metallic material
- II. Asteroids are found mostly between the orbits of Jupiter and Mars, while comets are found mostly between Venus and Mercury.
- III. Comets show a perceptible glowing tail, while asteroids do not.

Which of the statements given above is/are correct?

- a. I and II only
- b. I and III only**
- c. III only
- d. I, II and III

SPACE-TIME BENDING



BLACK HOLE



Mini

- ★ 1. **Miniature Blackhole**
2. **Stellar Blackhole**
3. **Intermediate Blackhole**
4. **Supermassive Blackhole**

Singularity

At the very centre of a black hole, matter has collapsed into a region of infinite density called a singularity. All the matter and energy that fall into the black hole ends up here. The prediction of infinite density by general relativity is thought to indicate the breakdown of the theory where quantum effects become important.

Event horizon

This is the radius around a singularity where matter and energy cannot escape the black hole's gravity: the point of no return. This is the "black" part of the black hole.

Photon sphere

Although the black hole itself is dark, photons are emitted from nearby hot plasma in jets or an accretion disc (see below). In the absence of gravity, these photons would travel in straight lines, but just outside the event horizon of a black hole, gravity is strong enough to bend their paths so that we see a bright ring surrounding a roughly circular dark "shadow". The Event Horizon Telescope is hoping to see both the ring and the "shadow".

Relativistic jets

When a black hole feeds on stars, gas or dust, the meal produces jets of particles and radiation blasting out from the black hole's poles at near light speed. They can extend for thousands of light-years into space. The GMVA will study how these jets form.

Innermost stable orbit

The inner edge of an accretion disc is the last place that material can orbit safely without the risk of falling past the point of no return.

Accretion disc

A disc of superheated gas and dust whirls around a black hole at immense speeds, producing electromagnetic radiation (X-rays, optical, infrared and radio) that reveal the black hole's location. Some of this material is doomed to cross the event horizon, while other parts may be forced out to create jets.

Accretion disc

Event horizon

Relativistic Jet

Singularity

Photon sphere

Innermost stable orbit

Expected Question

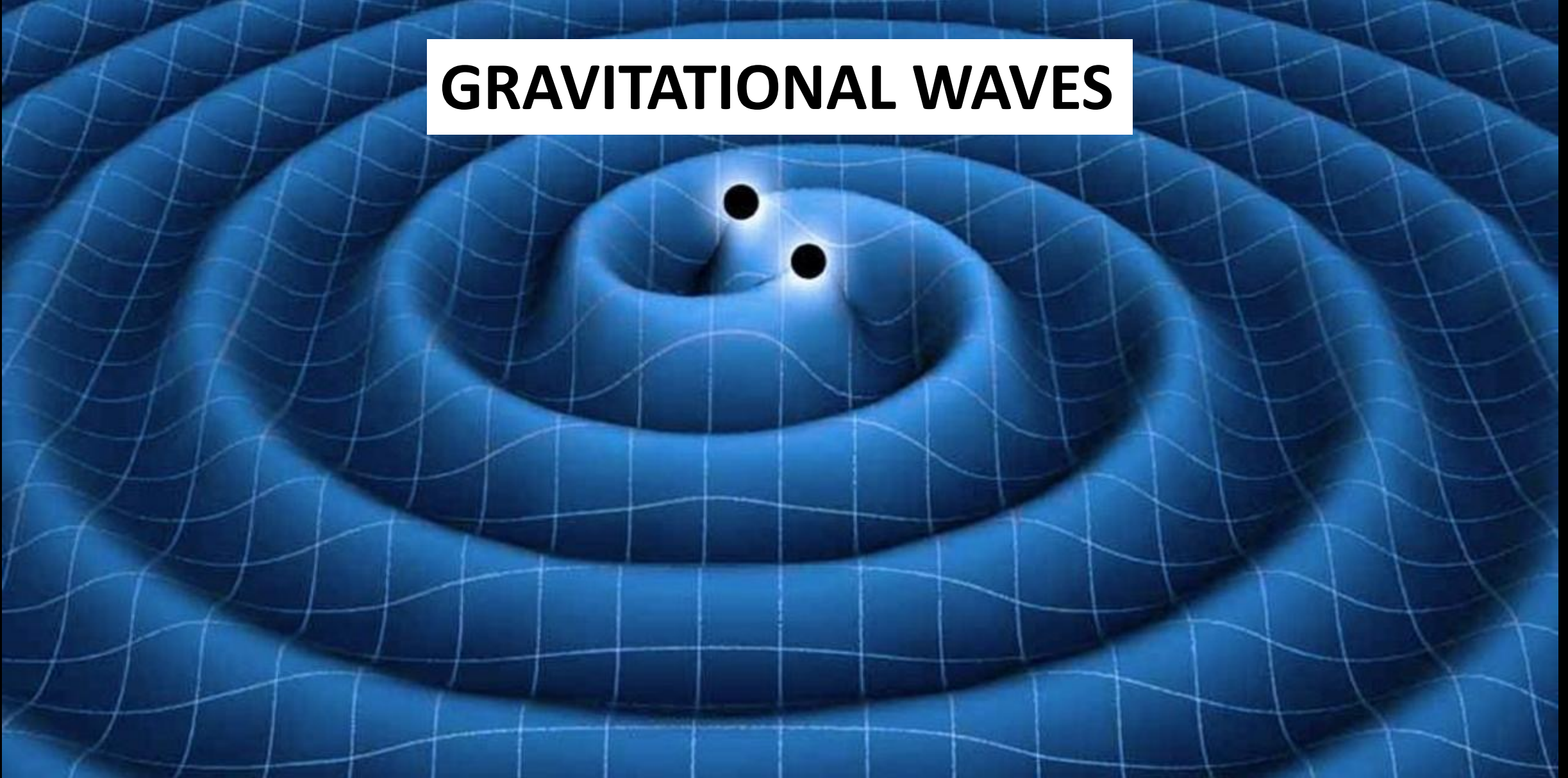
Choose the correct statement:

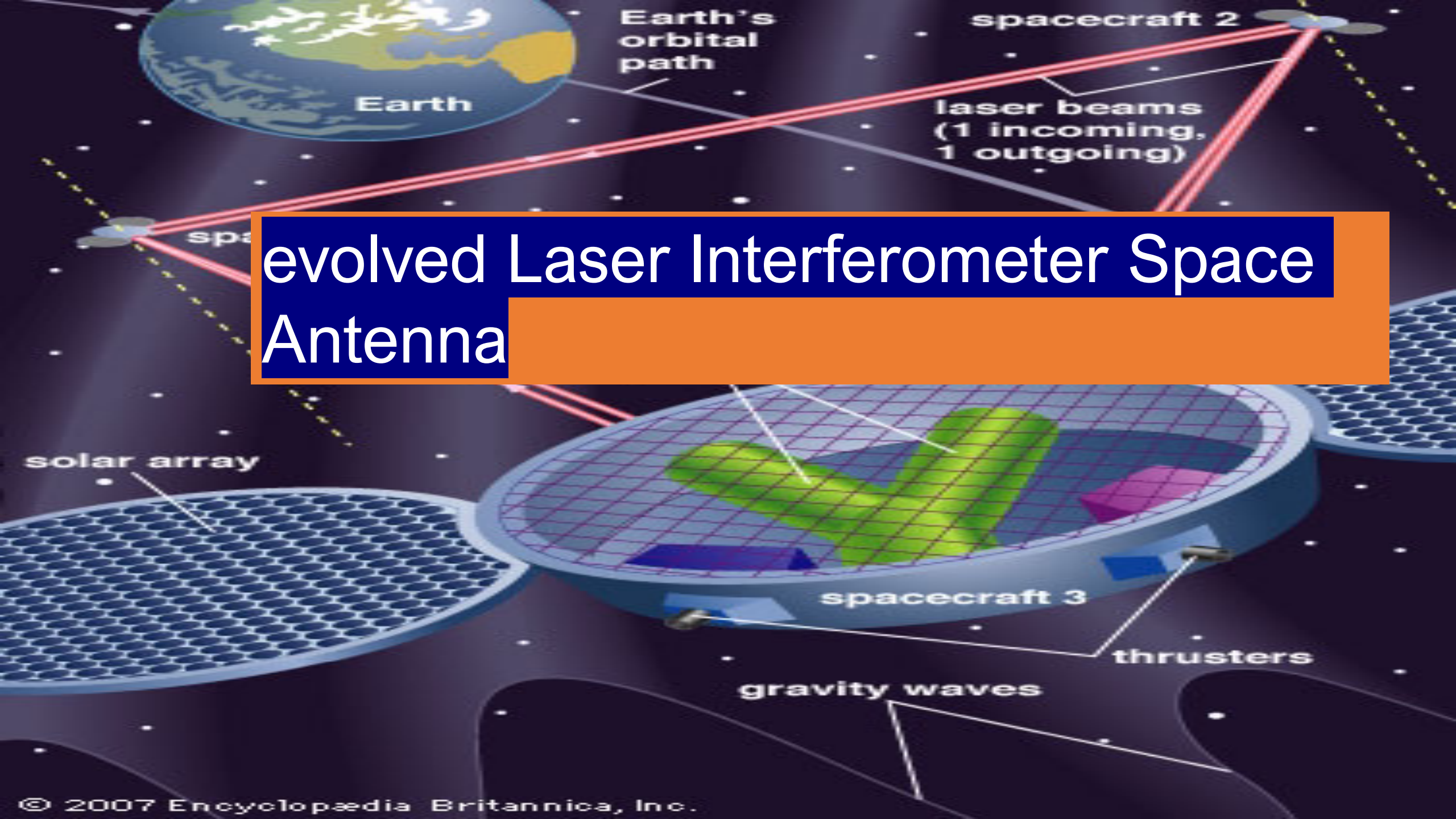
- I. Miniature Blackhole have the same mass as Mt. Everest.**
- II. When a massive star collapses it forms a Stellar Blackhole.**
- III. There is a Supermassive Blackhole at the centre of the milky way galaxy.**

Select the correct statement(s) using the codes given below:

- a. I & II**
- b. I & III**
- c. II & III**
- d. All of the above.**

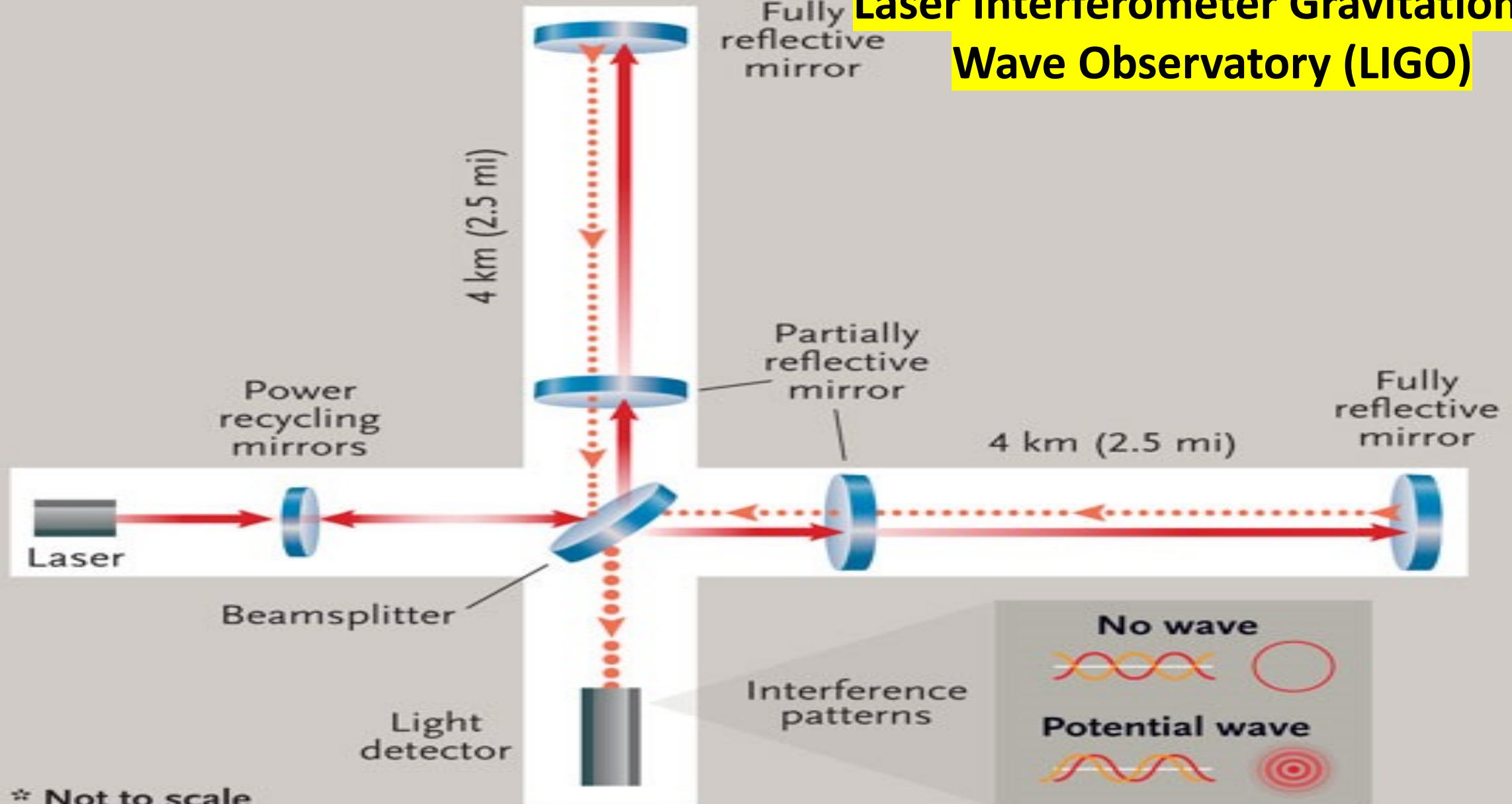
GRAVITATIONAL WAVES





evolved Laser Interferometer Space Antenna

Laser Interferometer Gravitational-Wave Observatory (LIGO)





LIGO India Project

Located near Aundha Nagnath, Hingoli District, Maharashtra

Previous Year (2017)

What is the purpose of 'evolved Laser Interferometer Space Antenna (eLISA)' project?

- a. To detect neutrinos
- b. To detect gravitational waves
- c. To detect the effectiveness of missile defence system
- d. To study the effect of solar flares on our communication systems

Expected Question

Which of the following statement(s) is/are true:

- I. Evolved Laser Interferometry Space Antenna comprises of two enormous laser interferometers located thousands of kilometres apart which exploits the physical properties of light and space to detect and understand the origins of Gravitational Waves.**
- II. Laser Interferometer Gravitational-Wave Observatory's primary objective is to detect and examine the gravitational waves emitted by the super-massive black holes.**

Choose the correct statement(s) using the codes given below:

- a. I Only**
- b. II Only**
- c. Both I & II**
- d. None of the above.**

HABITABLE ZONE

Habitable-Zone Planet Finder (HPF)

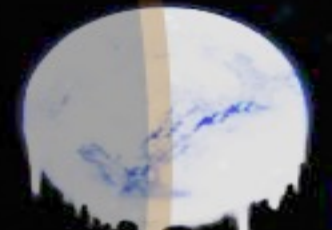
Planet size 1-2x Earth



Too hot!

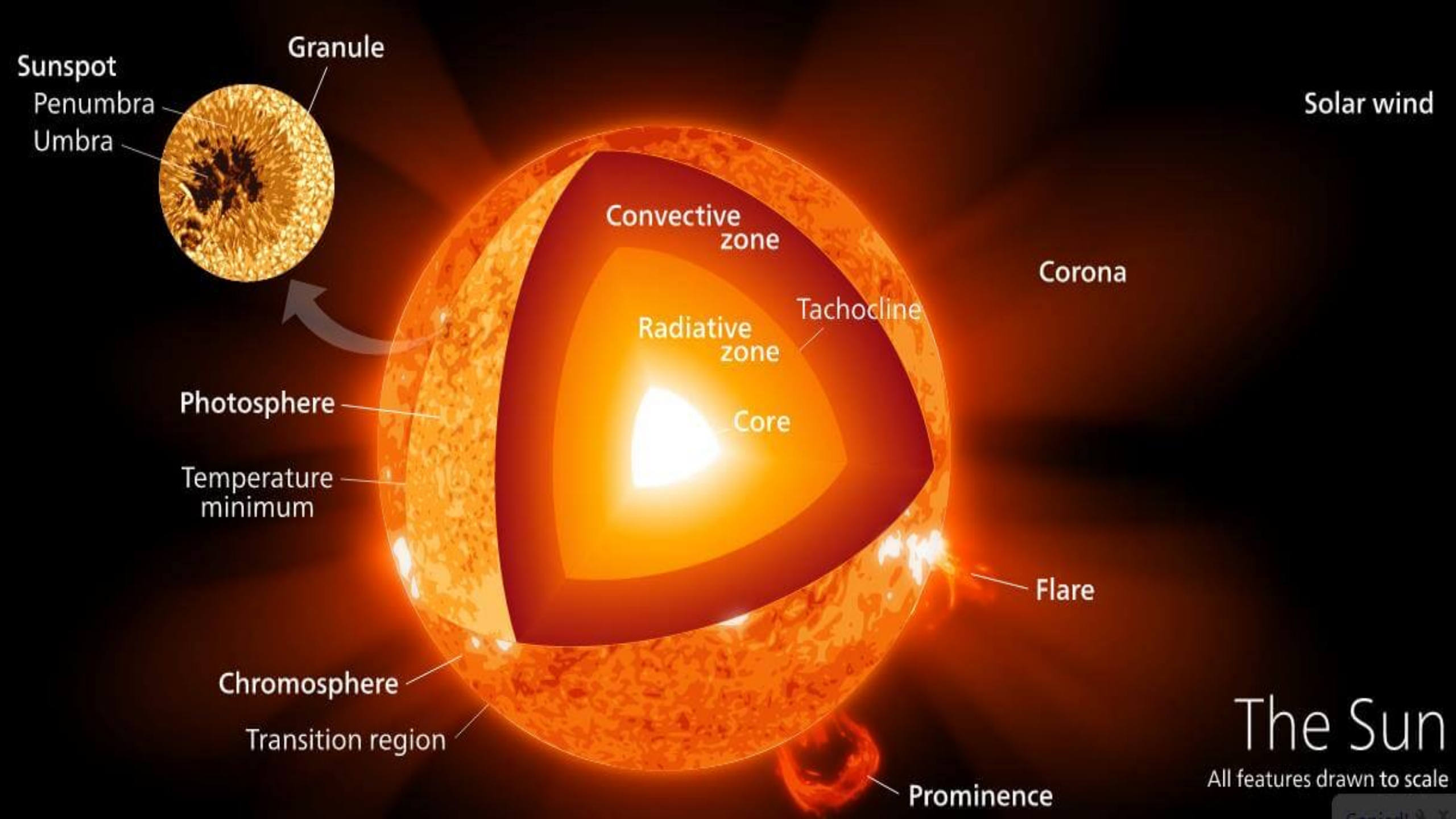


Just right!



Too cold!





Sunspot
Penumbra
Umbra

Granule

Solar wind

Convective
zone

Corona

Radiative
zone

Tachocline

Photosphere

Core

Temperature
minimum

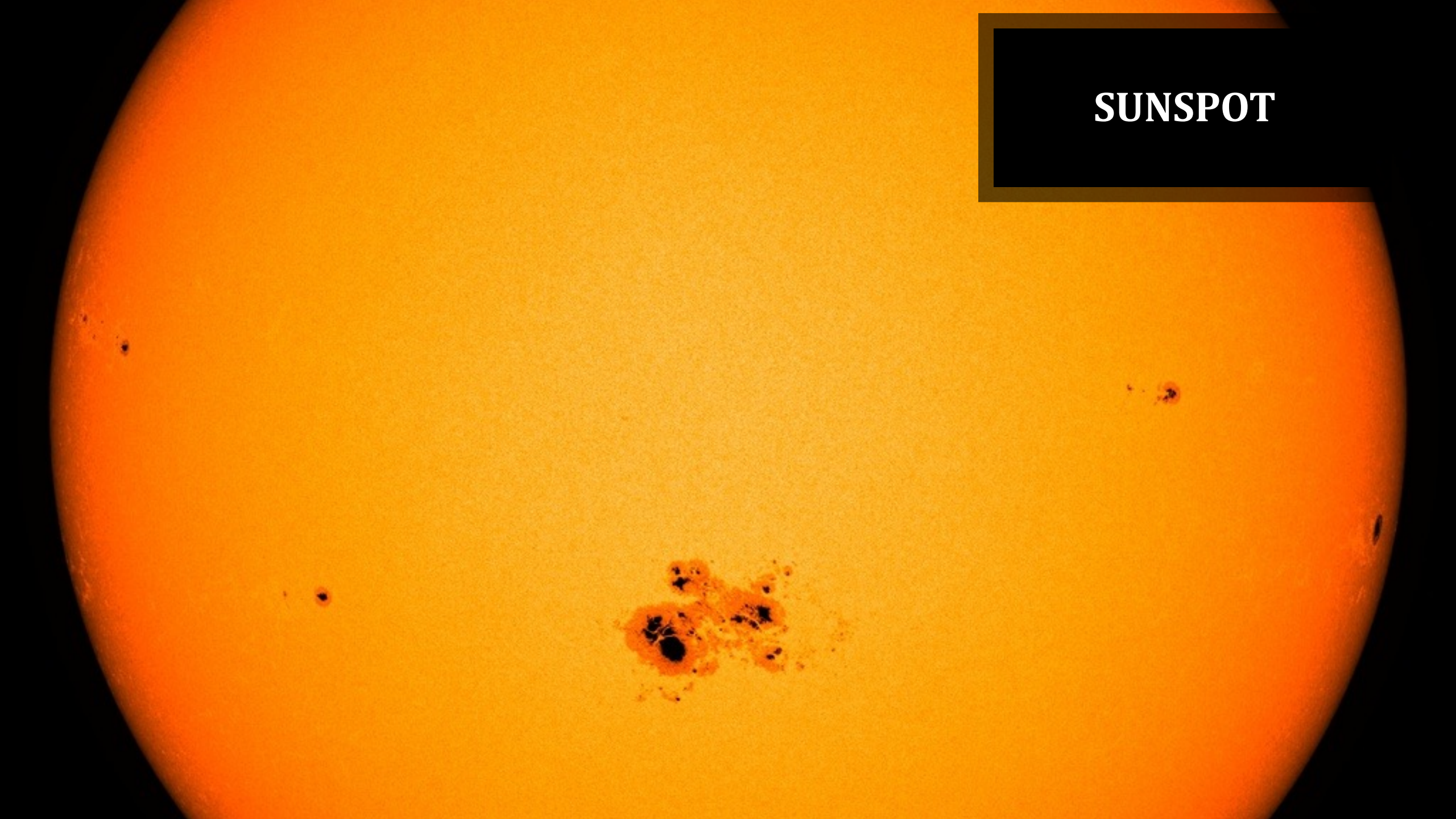
Flare

Chromosphere

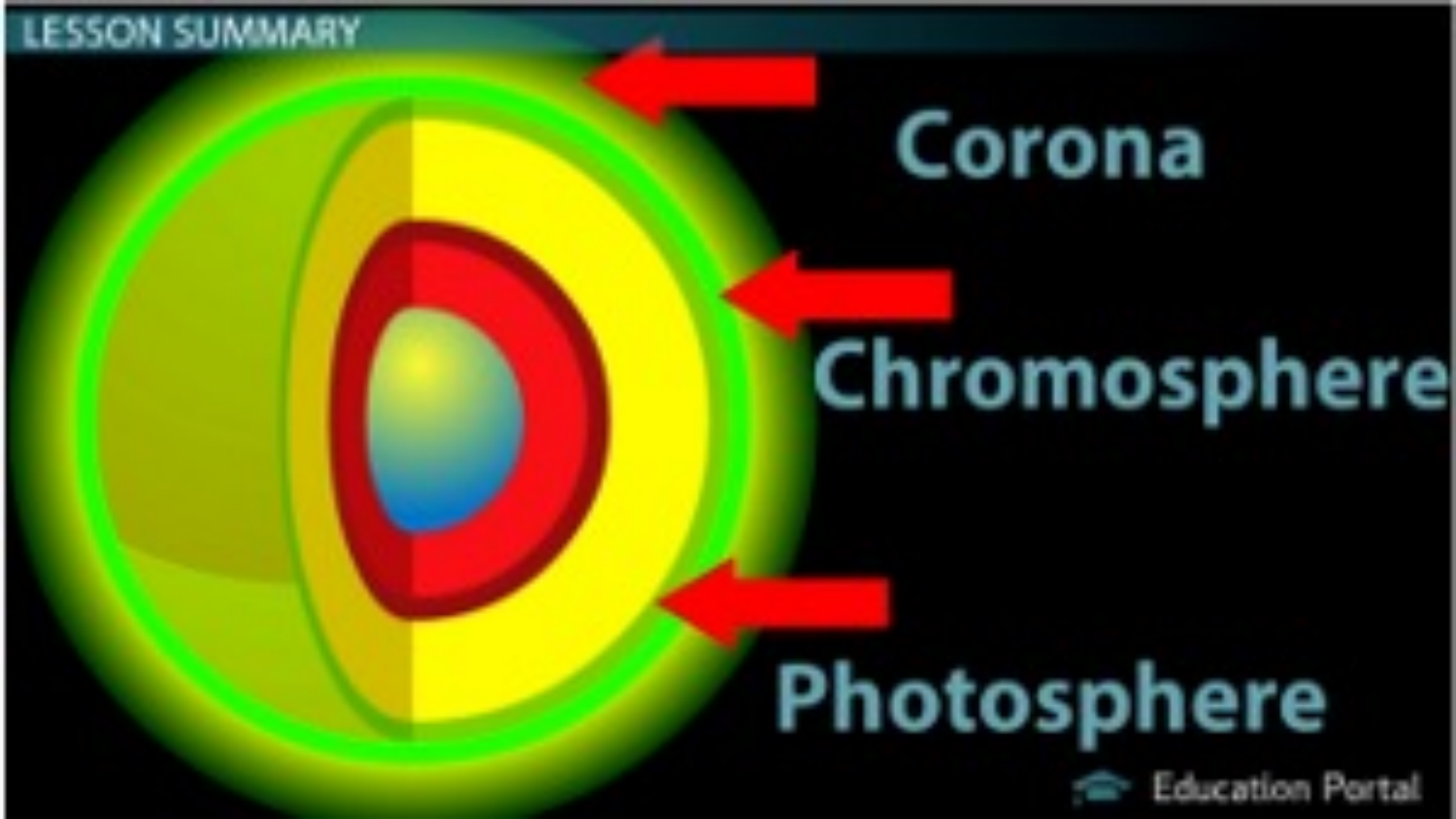
Transition region

Prominence

The Sun
All features drawn to scale



SUNSPOT



Corona

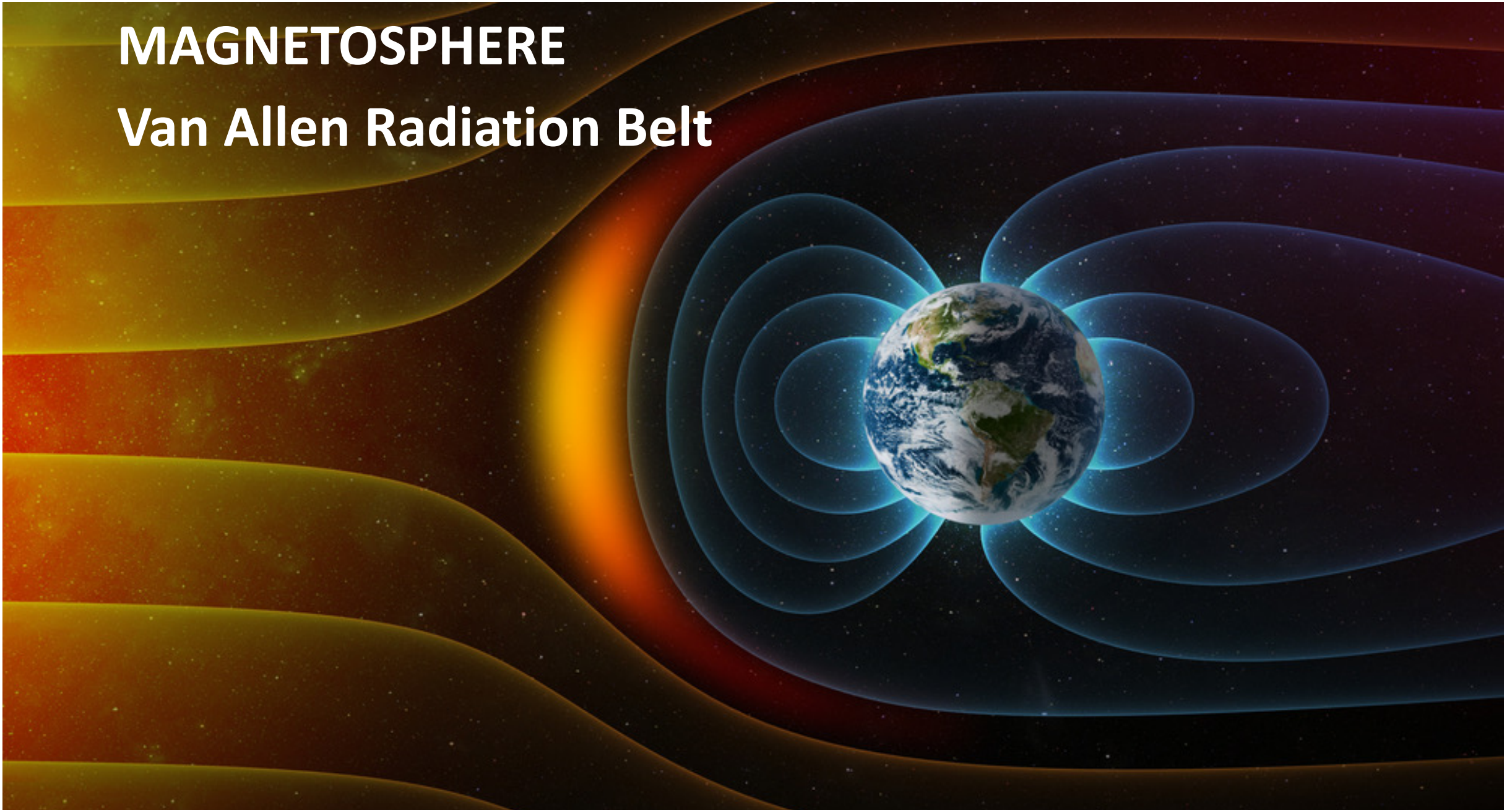
Chromosphere

Photosphere



MAGNETOSPHERE

Van Allen Radiation Belt



- 1. Dynamo theory:** Generation of Earth's Magnetic Field and Sustaining it, flow of liquid iron generates electric currents, which in turn produce magnetic fields.
- 2. Magnetosphere:** the region above the ionosphere, protecting the Earth from the charged particles of the solar wind and cosmic rays
- 3. Sun's magnetosphere called heliosphere**
- 4. Van Allen radiation belt:** zone of energetic charged particles, most of which originate from the solar wind, that are captured by and held around a planet by that planet's magnetic field.
- 5. Geo Magnetic Storms:** when a coronal mass ejection erupts above the Sun and sends a shock wave through the Solar System.
- 6. Auroras:** Positive ions slowly drift westward, and negative ions drift eastward, giving rise to a ring current.
- 7: Helioseismology:** By tracking sound waves that course through the center of the sun

- Even though the interstellar medium has a low density, it still has a **pressure** (similar to air pressure). The solar wind also has pressure. It blows against the interstellar medium and creates a **bubble-like region**. This bubble that surrounds the solar system is called the **heliosphere** (not a sphere in the true sense).
- Since the Sun is moving relative to the interstellar medium around it, the heliosphere forms a wave or shock in the interstellar medium like a boat in the ocean. This is called the **bow shock or wave**.
- The region where the solar wind **begins to interact with the interstellar medium** and **begins to slow down** is called the **heliosheath**.
- The heliosheath has a few parts: the **termination shock** (the innermost part of the boundary), the **heliopause** (the outermost part of the boundary) and the part in between the inner and outer boundary.
- The **termination shock** is the boundary where the solar wind particles slow down so that the particles are travelling **slower than the speed of sound**.
- At the **heliopause** — the boundary of the heliosphere, the pressure from the interstellar medium is strong enough to slow down and eventually stop the flow of solar wind.
- Voyager 1 crossed the termination shock at 94 astronomical units (AU) and Voyager 2 crossed at 84 AU.

Expected Question

Which of the following statement(s) is/are true regarding Sun spots:

- I. Each spot has a black centre called umbra, and a lighter region called penumbra.
- II. Sun Spots decreases the solar winds.
- III. Sun Spots form due to magnetic anomalies of the interior of the Sun.

Select the correct code:

- | | |
|-------------|---------------------|
| a. I & II | c. I & III |
| b. II & III | d. All of the above |

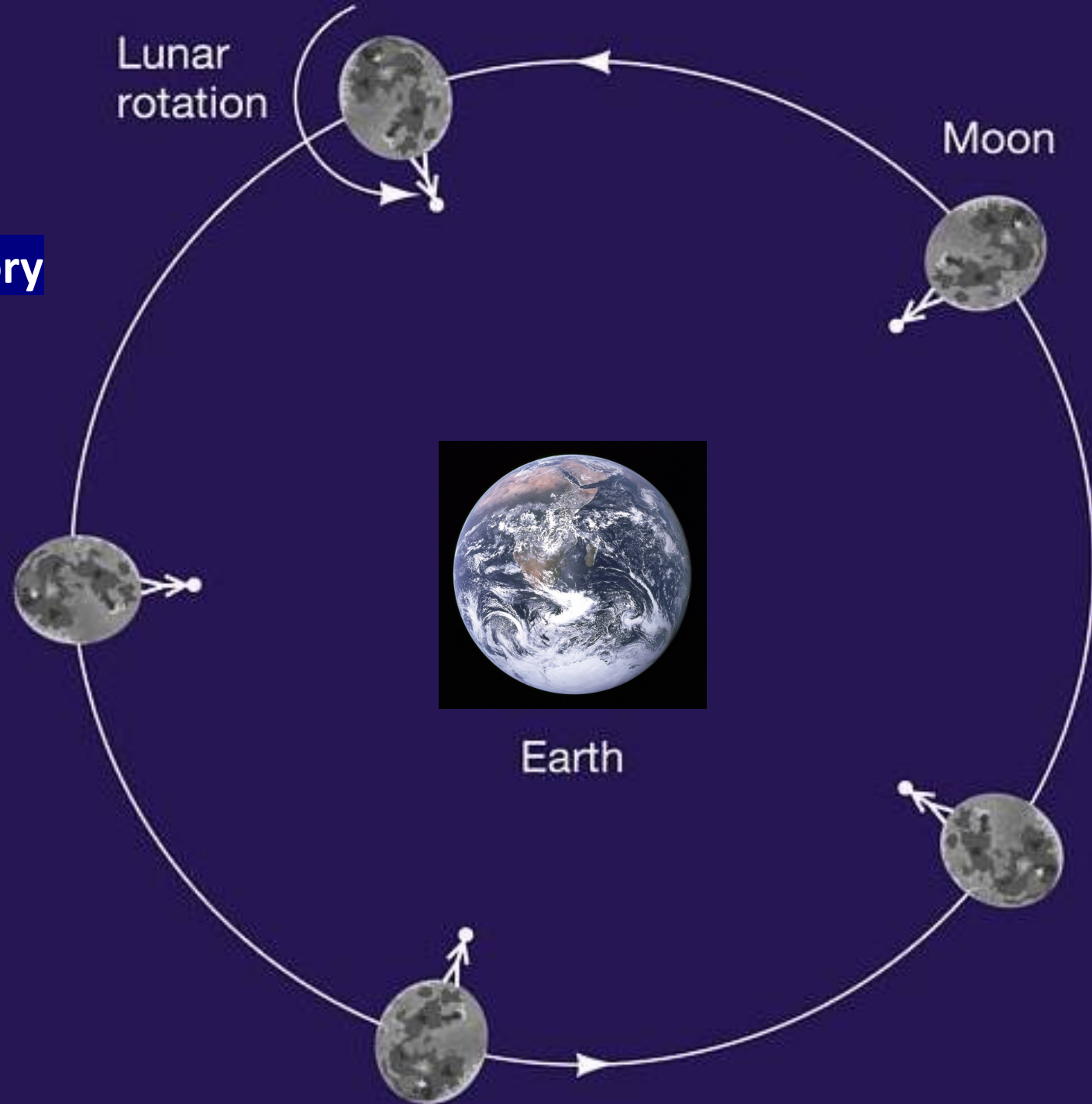
The MOON

Giant impact theory

Tidal Locking

Apogee

Perigee





- **Fission Theory**
- spinning so fast that part of our planet spun off into space but was kept tethered by Earth's gravity.
- the Pacific Ocean might be the site where the would-be moon material came off of Earth
- after moon rocks were analyzed, the moon rock compositions differed from those in the Pacific Ocean.

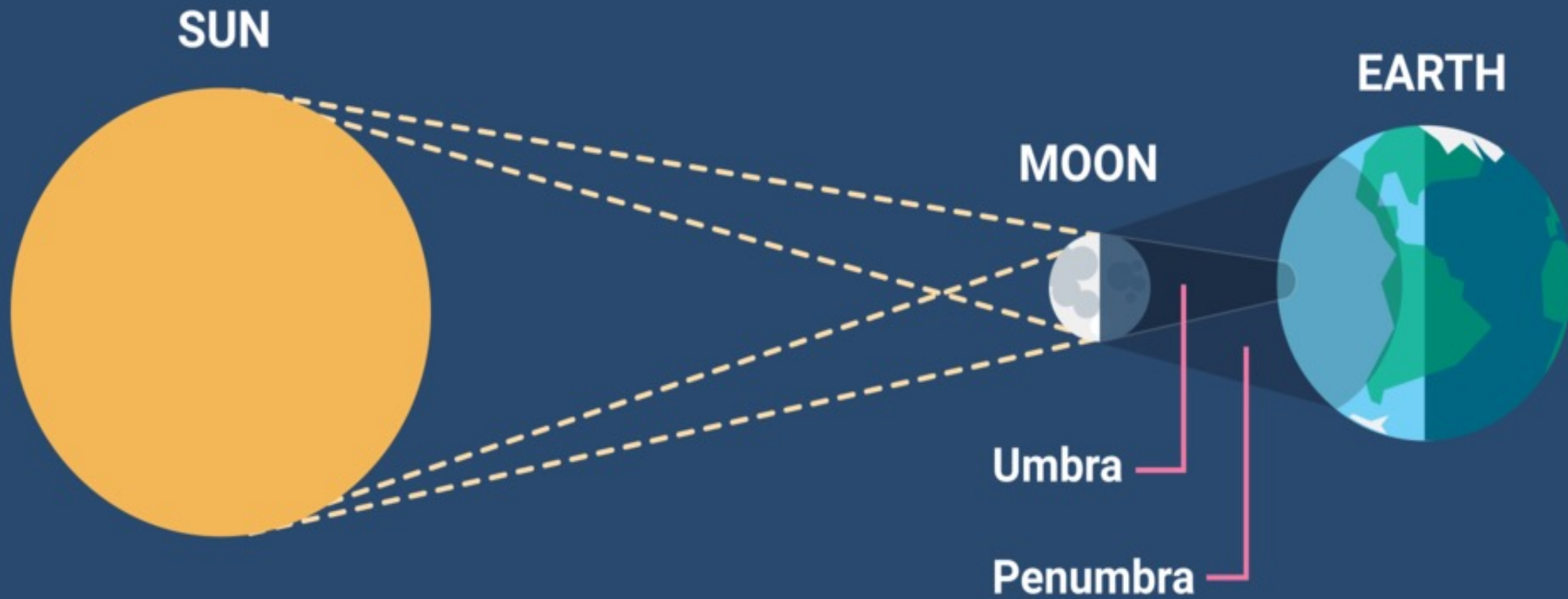
2. Capture Theory

- the moon originated elsewhere in the Milky Way, completely independent of Earth
- while traveling past Earth, the moon got trapped in our planet's gravity.
- the moon would have eventually broken free from Earth's gravity because Earth's gravity would have been massively altered by catching the moon.

3. Co-Accretion Theory

- Also known as the condensation theory
- the moon and the Earth formed together while orbiting a black hole.
- neglects an explanation of why the moon orbits the Earth

SOLAR ECLIPSE



Types of Solar Eclipses



PARTIAL

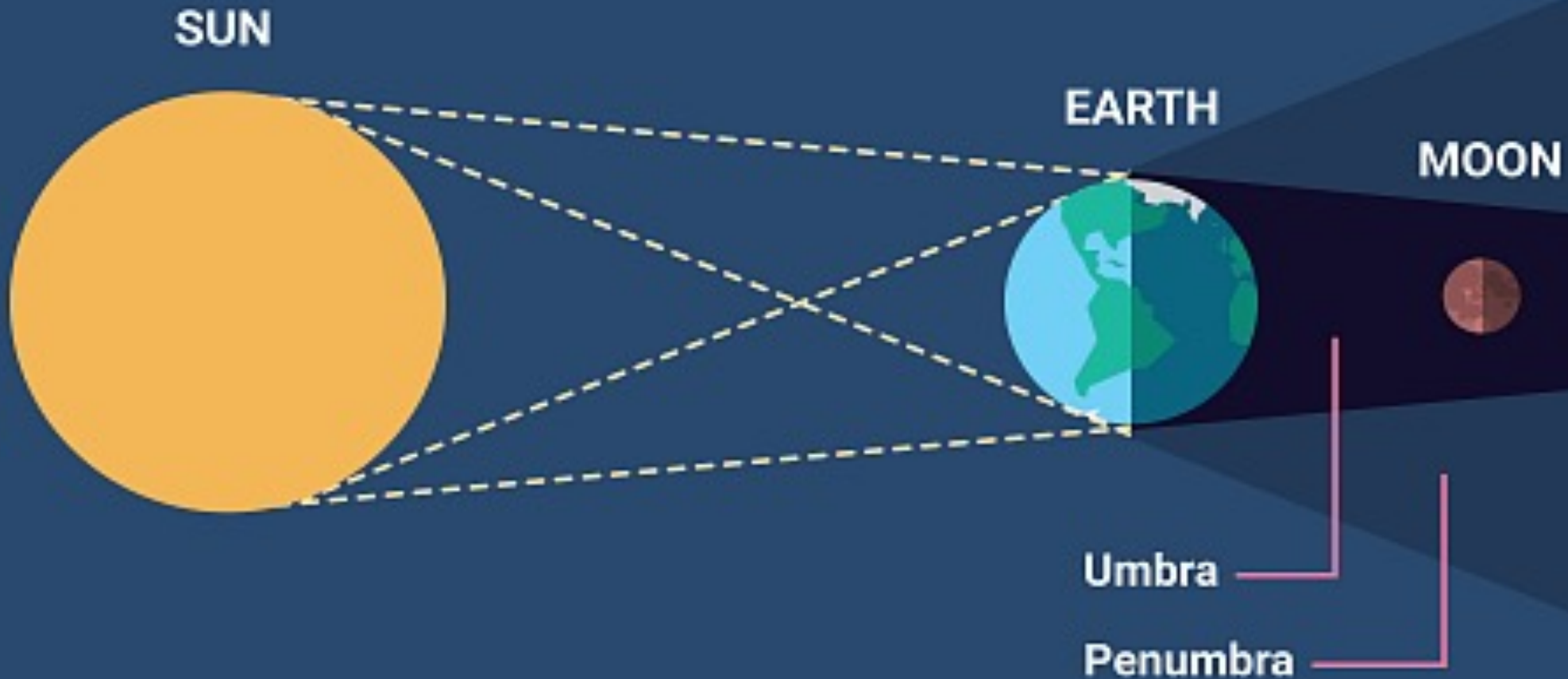


ANNULAR



TOTAL

LUNAR ECLIPSE



3 TYPES OF LUNAR ECLIPSES



TOTAL



PARTIAL



PENUMBRAL

Expected Question

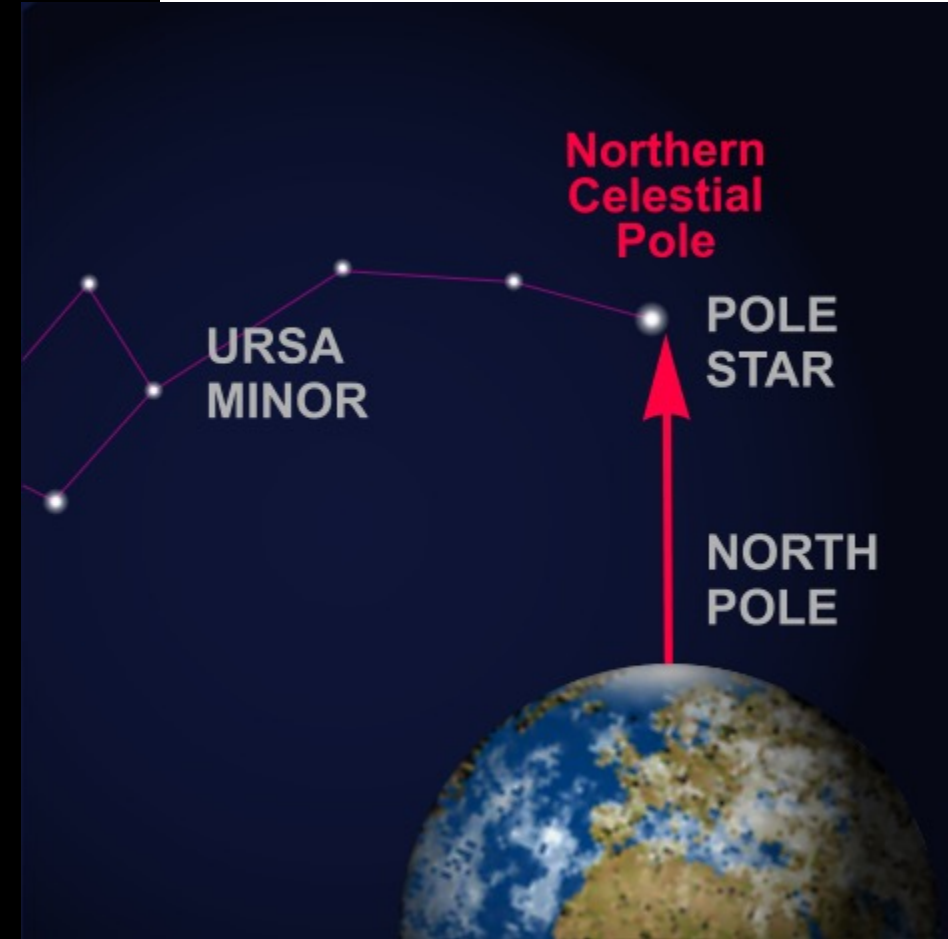
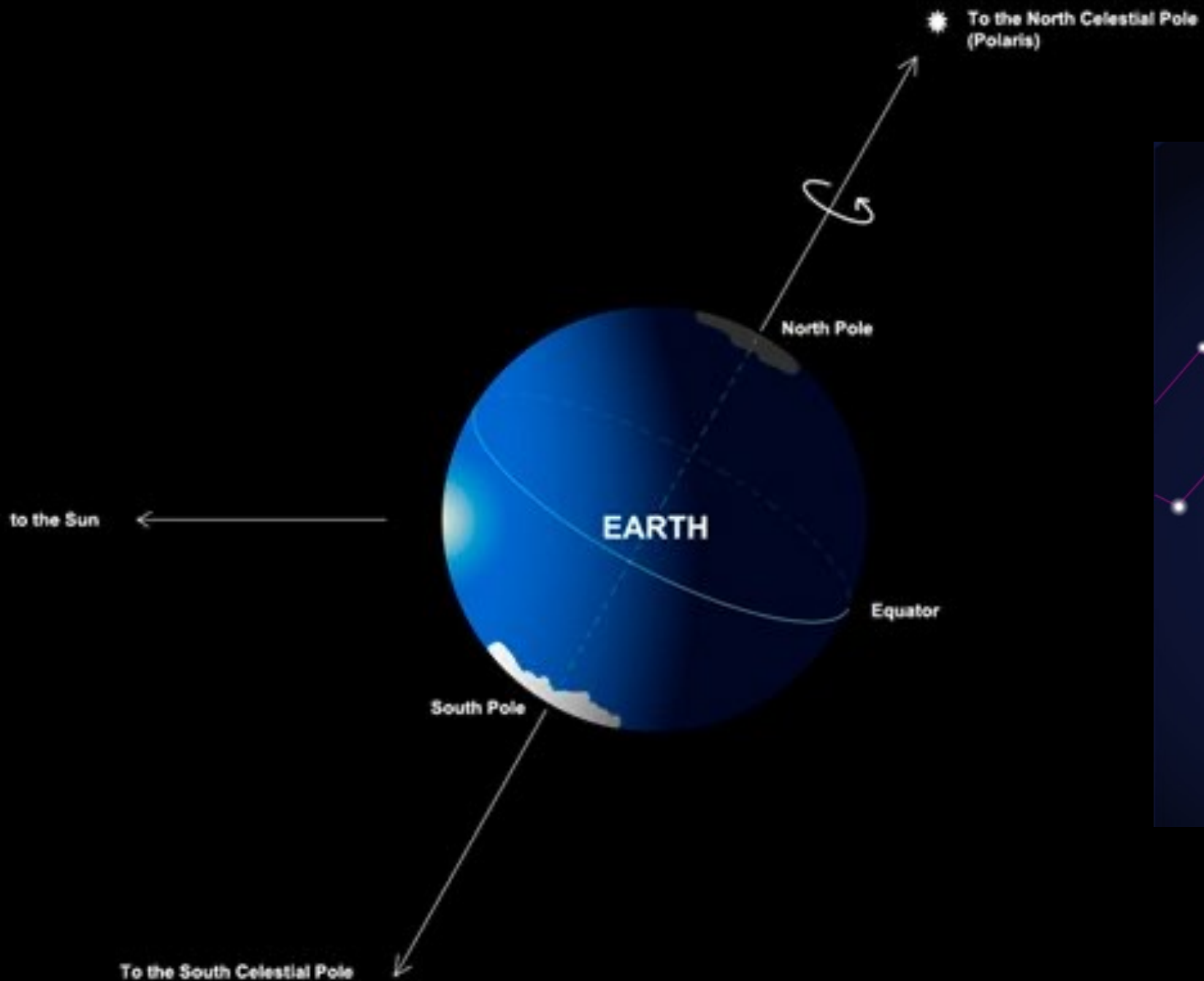
Consider the following statements:

- I. The same face of the Moon is always presented to the Earth.
- II. The Moon rotates about its own axis in 27 days.
- III. The moon is tidally locked to the earth.
- IV. When Moon's orbit closest to Earth is called apogee and the point farthest away is the perigee.

Choose the correct statement(s) using the codes given below:

- a. I & II
- b. III & IV
- c. I, II & III
- d. All of the above.

POLE STAR



Polaris



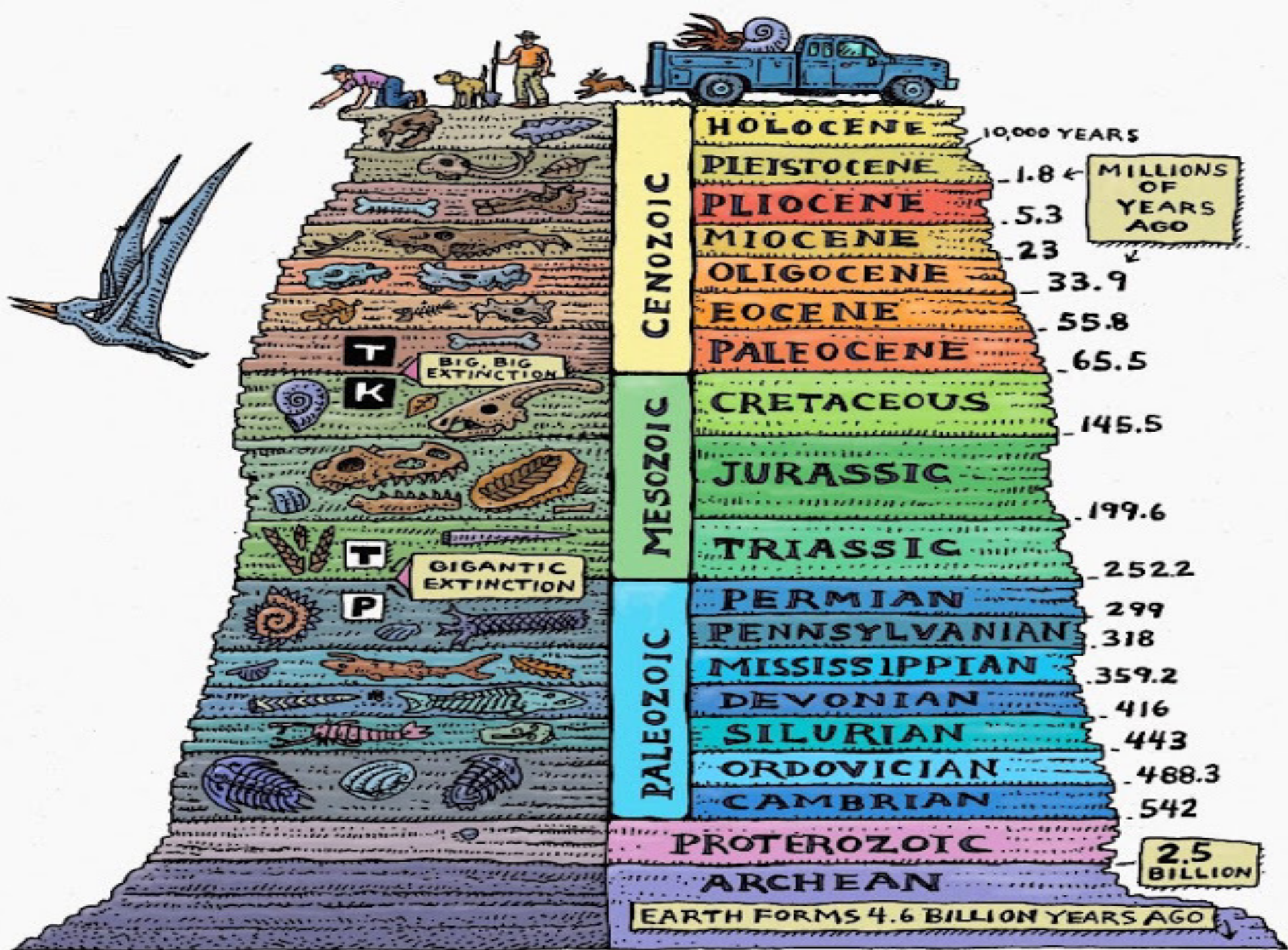
PREVIOUS YEAR QUESTION 2012

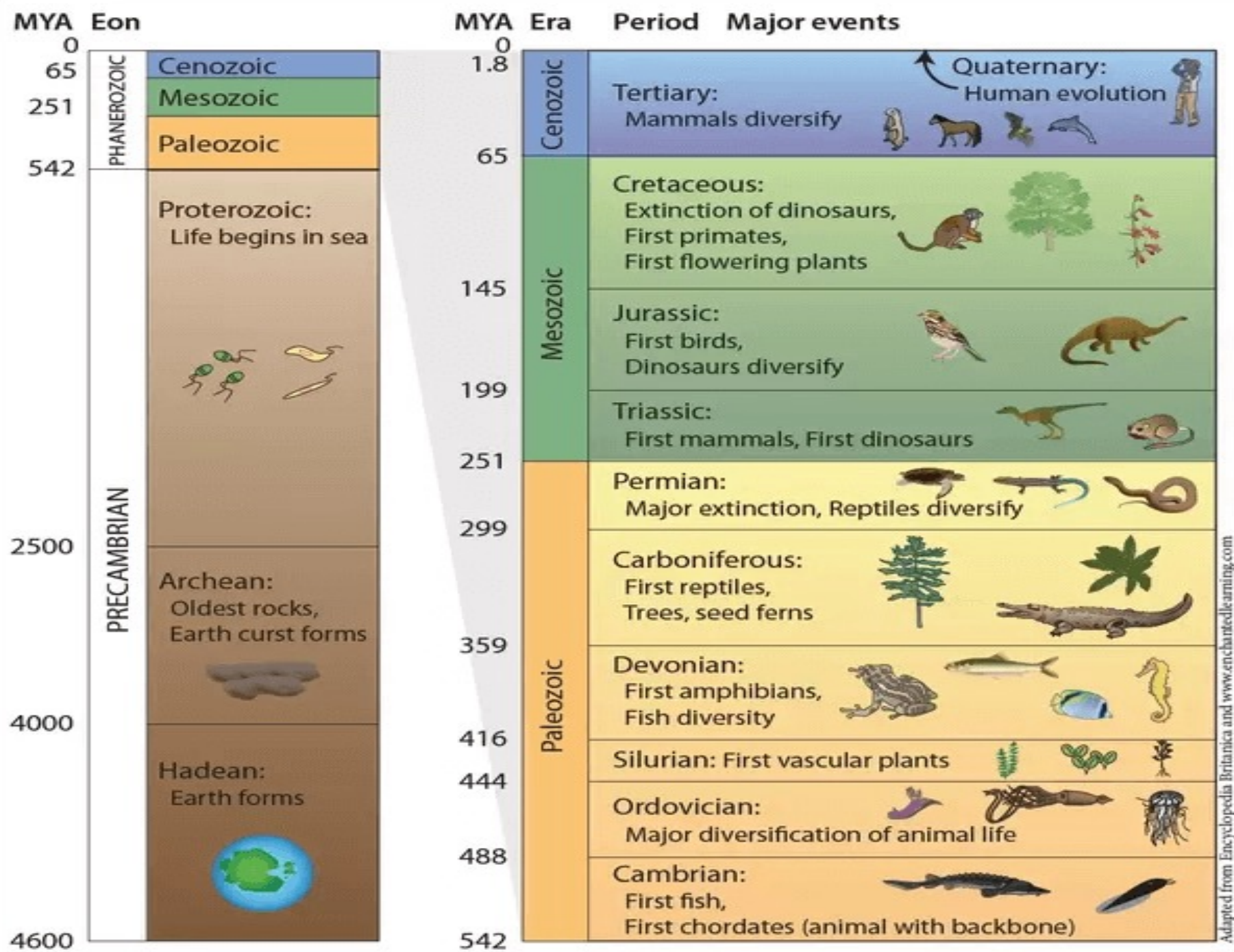
A person stood alone in a desert on a dark night and wanted to reach his village which was situated 5 km east of the point where he was standing. He had no instruments to find the direction, but he located the polestar. The most convenient way now to reach his village is to walk in the (2012)

- (a) direction facing the polestar**
- (b) direction opposite to the polestar**
- (c) direction keeping the polestar to his left**
- (d) direction keeping the polestar to his right**



ORIGIN AND EVOLUTION OF EARTH

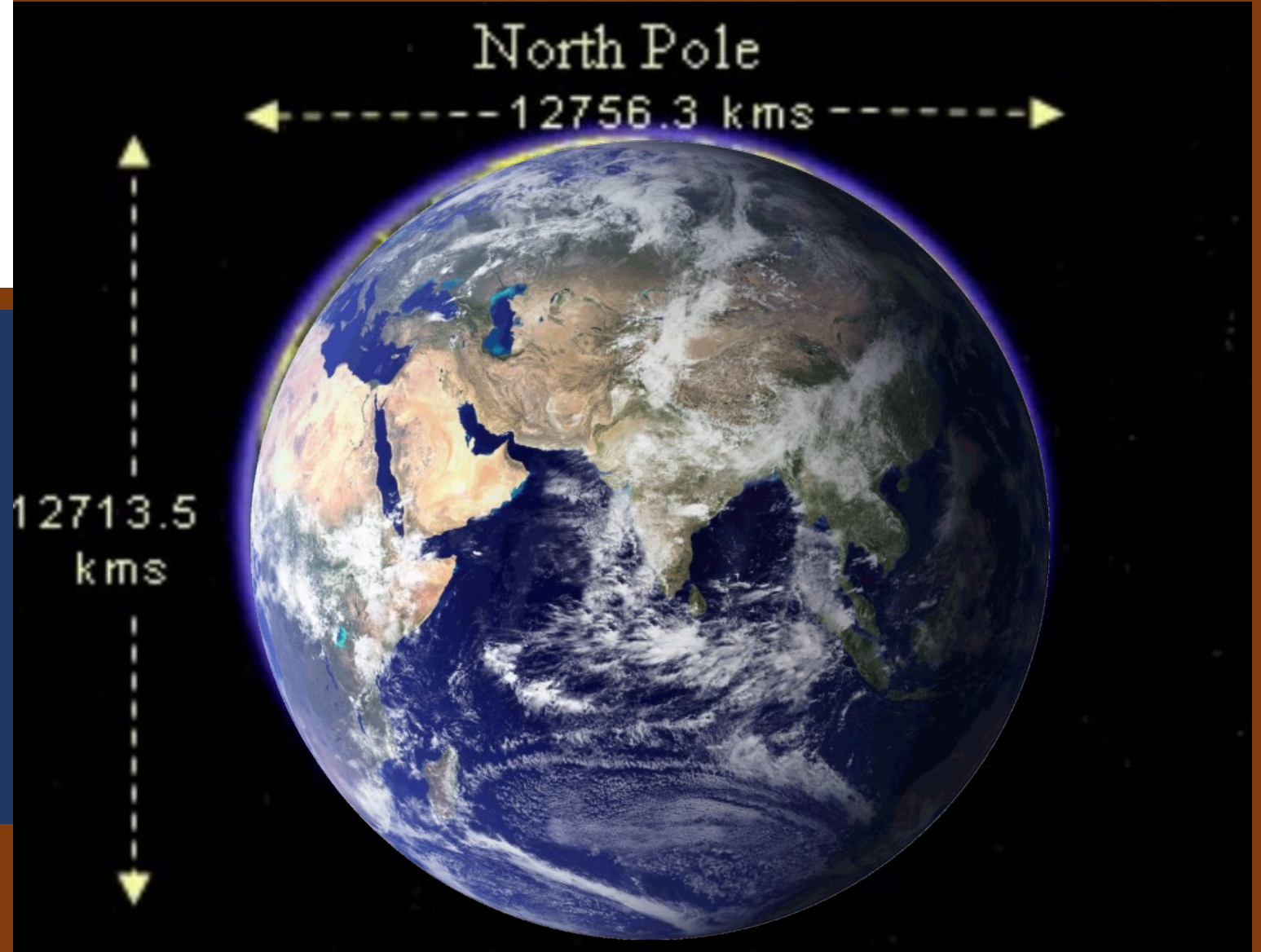




Adapted from Encyclopedia Britannica and www.enchantedlearning.com

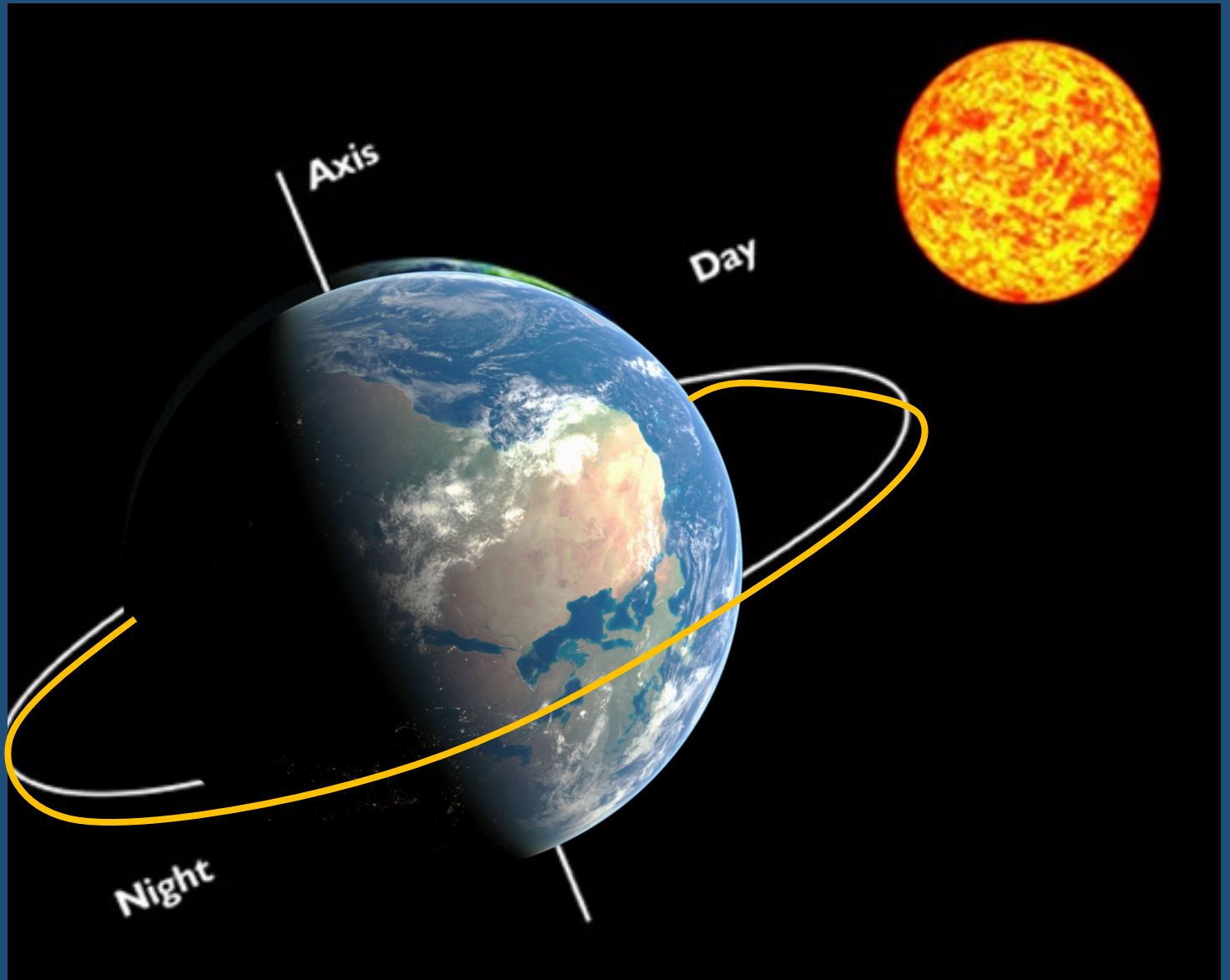
SHAPE OF THE EARTH

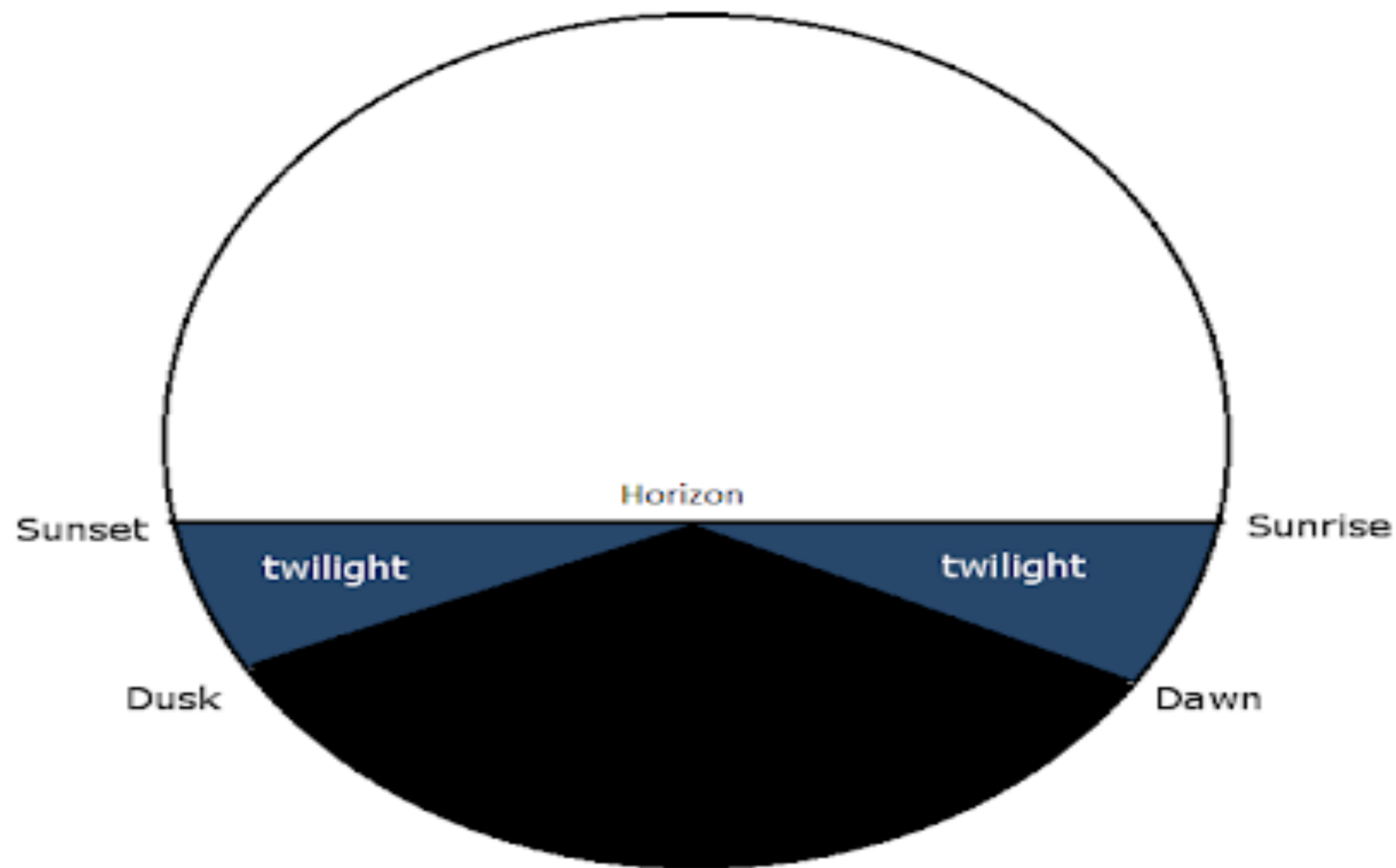
- Oblate Spheroid
- Ellipsoid
- Geoid
- Sphere
- Pear shape



THE EARTH'S ROTATION

- West to east
- 24 hours
- Daylight and darkness
- Sunrise and Sunset
- Axial tilt





Previous Year (2018)

Consider the following statements:

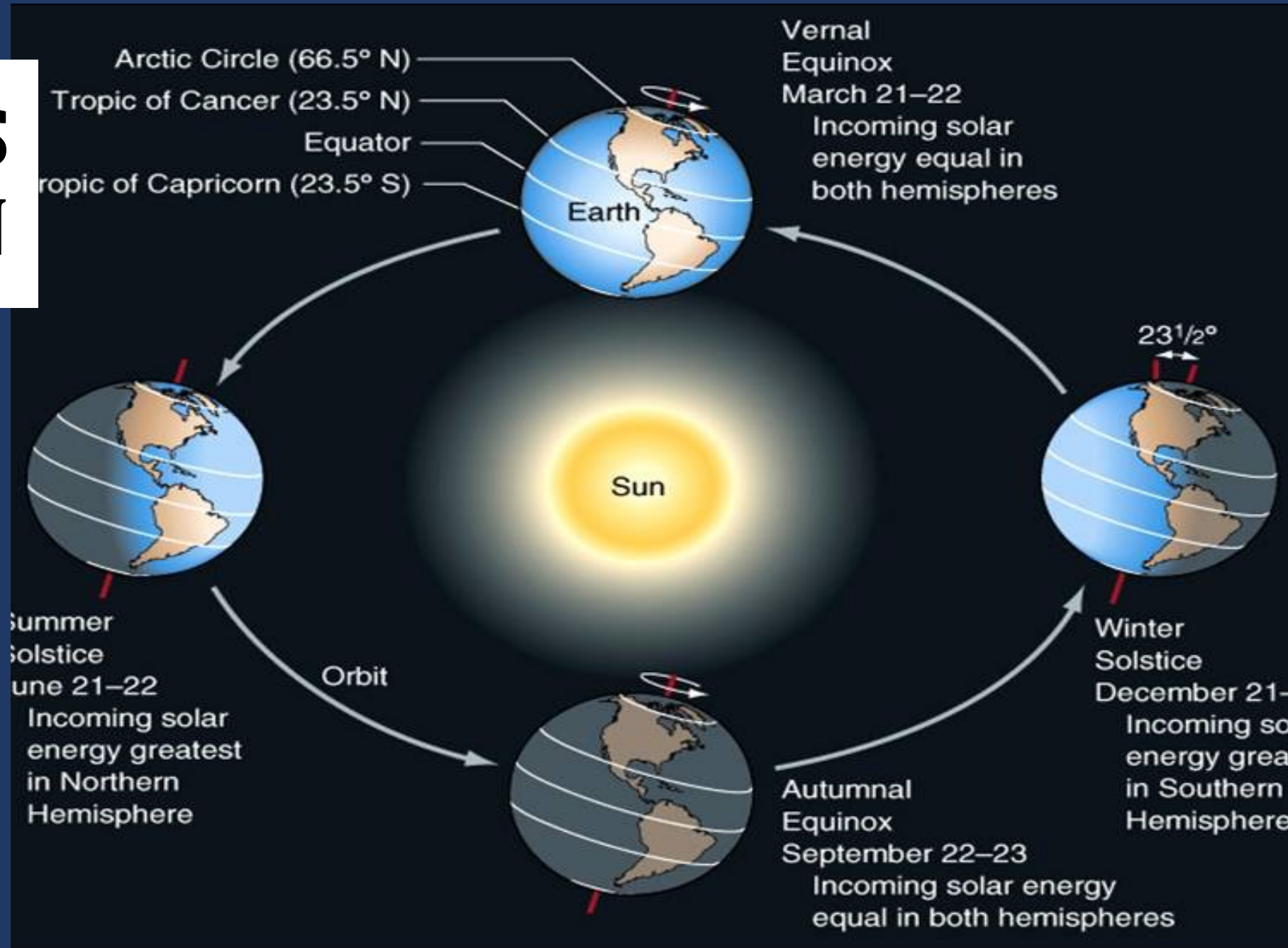
- I. The Earth's magnetic field has reversed every few hundred thousand years.
- II. When the Earth was created more than 4000 million years ago, there was 54% oxygen and no carbon dioxide.
- III. When living organisms originated, they modified the early atmosphere of the Earth.

Which of the statements given above is/are correct?

- (a) I only (b) II and III only (c) I and III only (d) I, II and III

THE EARTH'S REVOLUTION

- Elliptical orbit
- Speed - 29.8 km/s
- 365 $\frac{1}{4}$ days - Leap Year

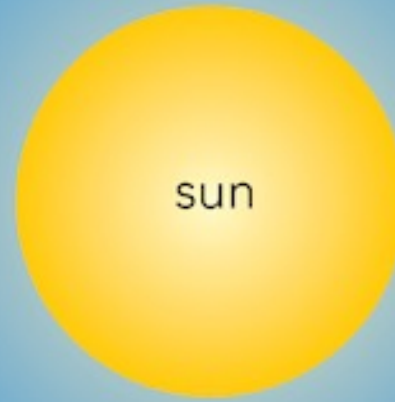
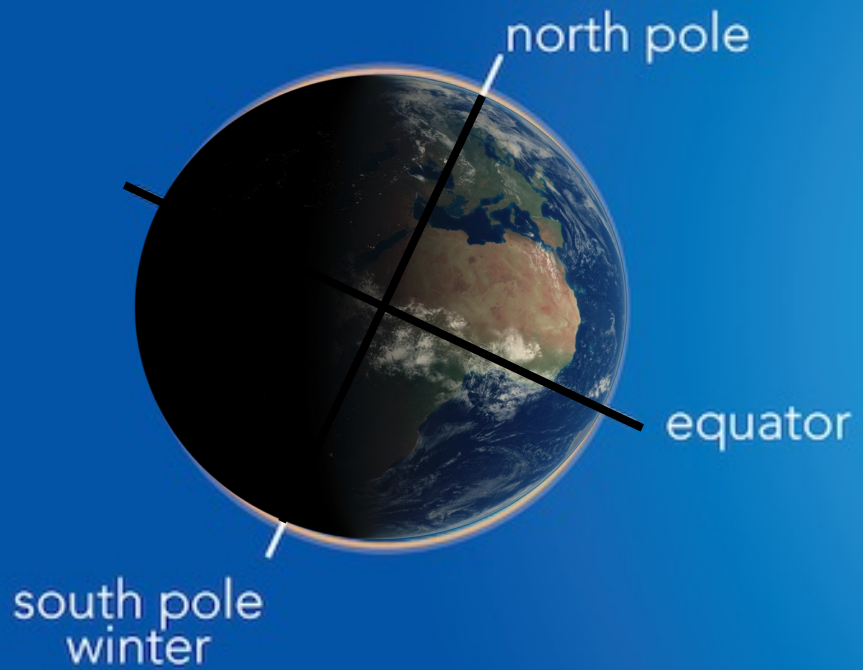


Kepler's Law of Planetary Motion:

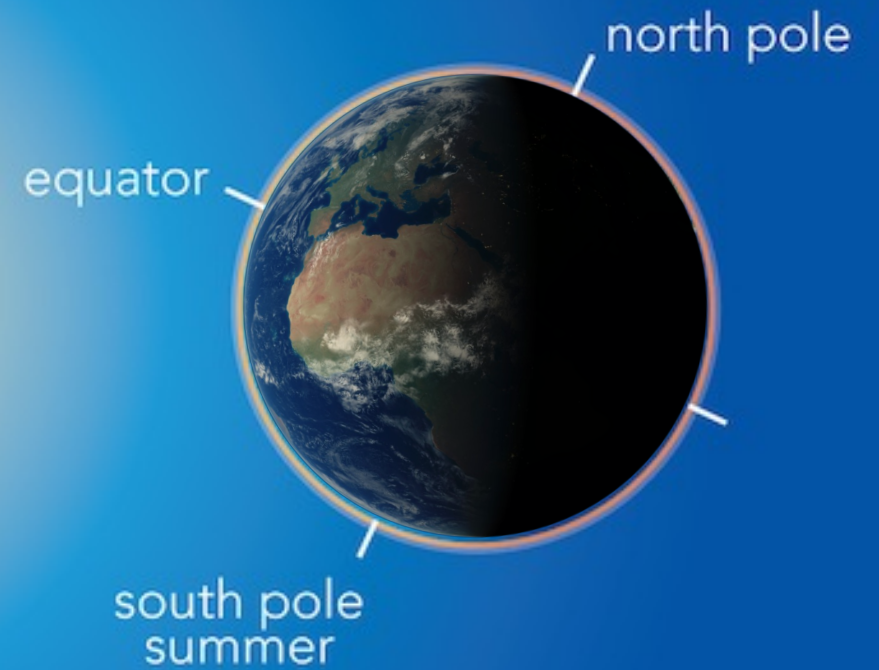
1 : a statement in astronomy: The orbit of each planet is an ellipse that has the sun at one focus.

2 : a statement in astronomy: The radius vector from the sun to each planet generates equal orbital areas in equal times.

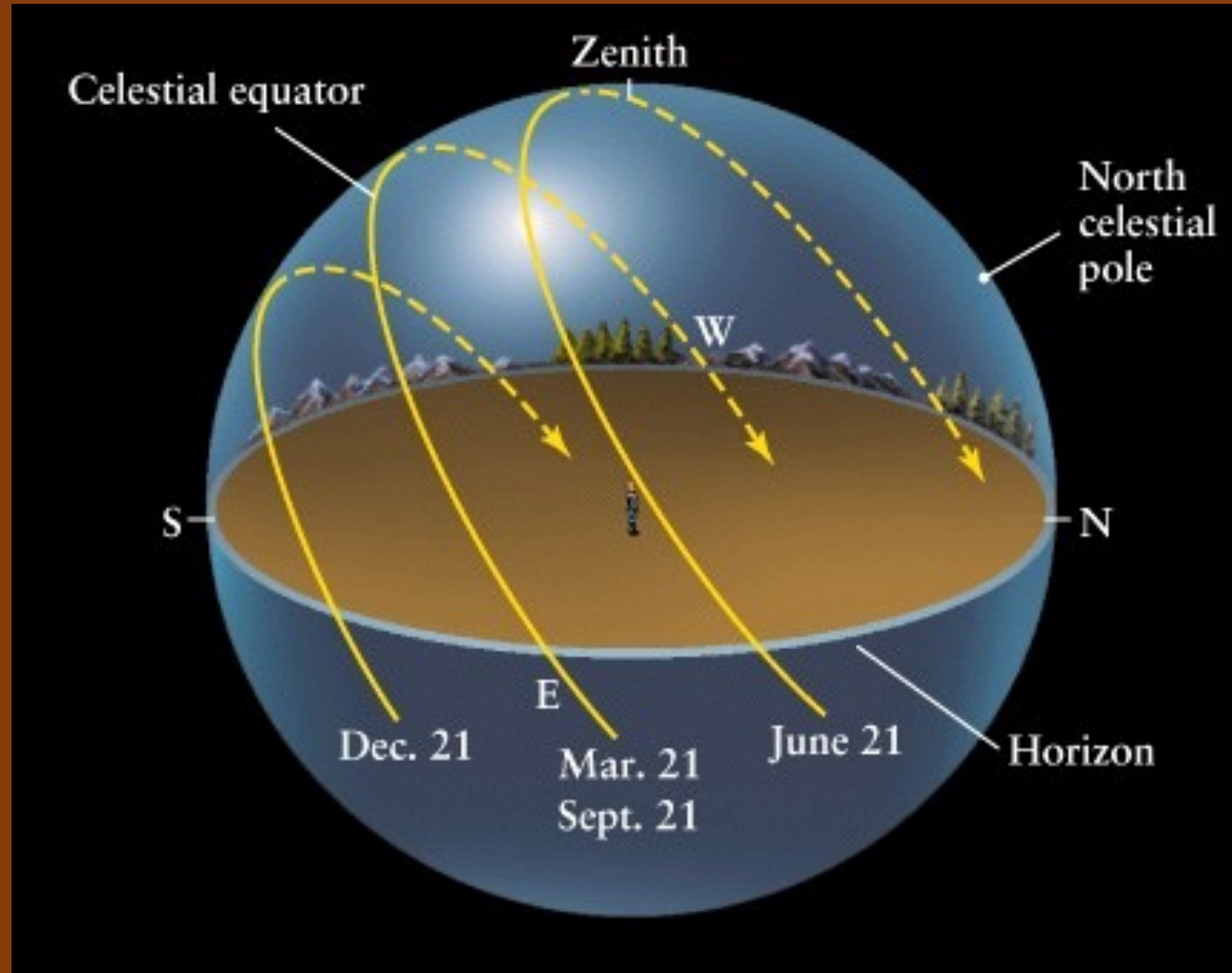
Summer Solstice

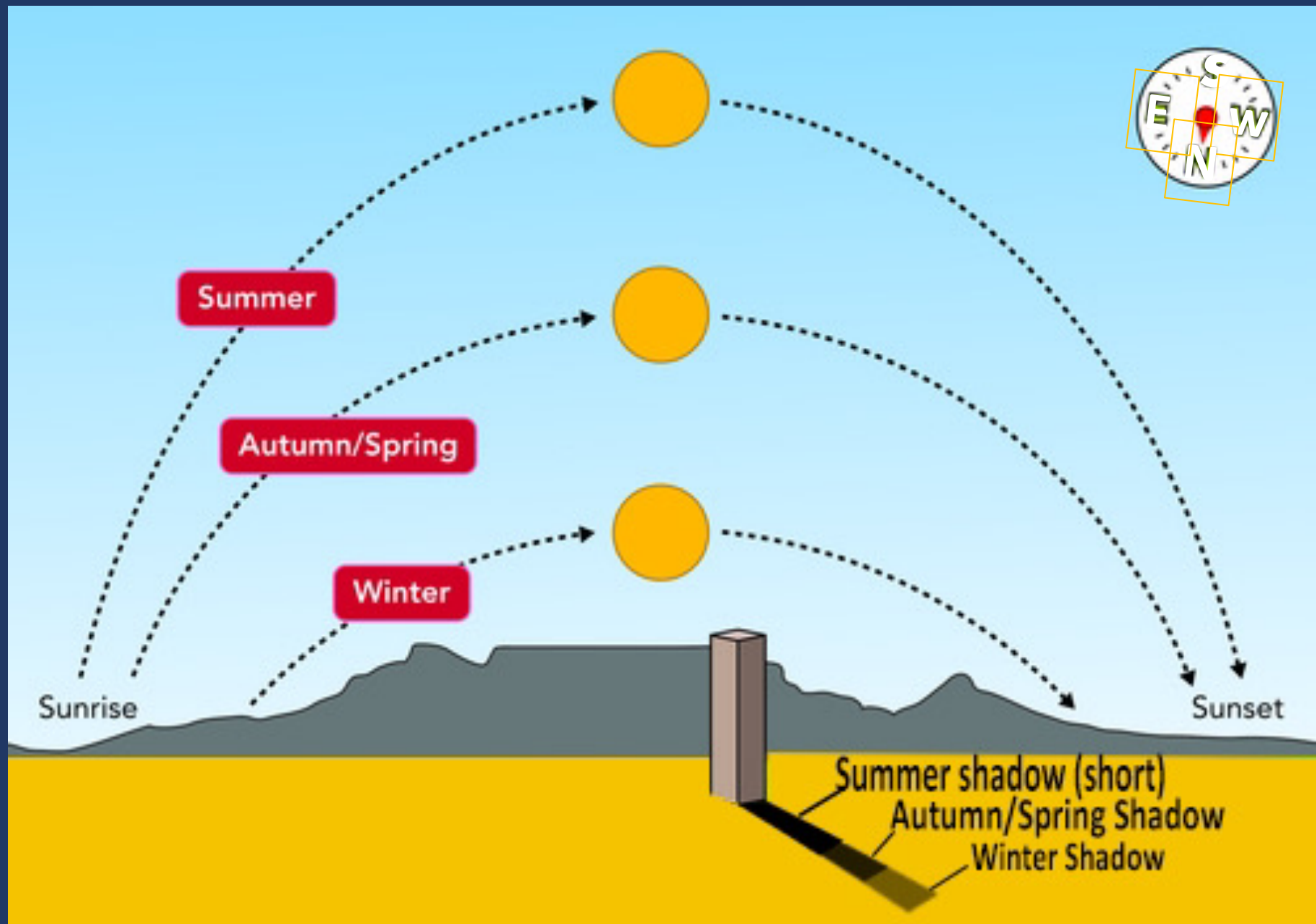


Winter Solstice



VARYING ALTITUDE OF MID-DAY SUN





Expected Question

What is/are the major cause(s) for faster movement of the Earth in its Orbit in Perihelion and comparatively slower motion of the Earth in Aphelion:

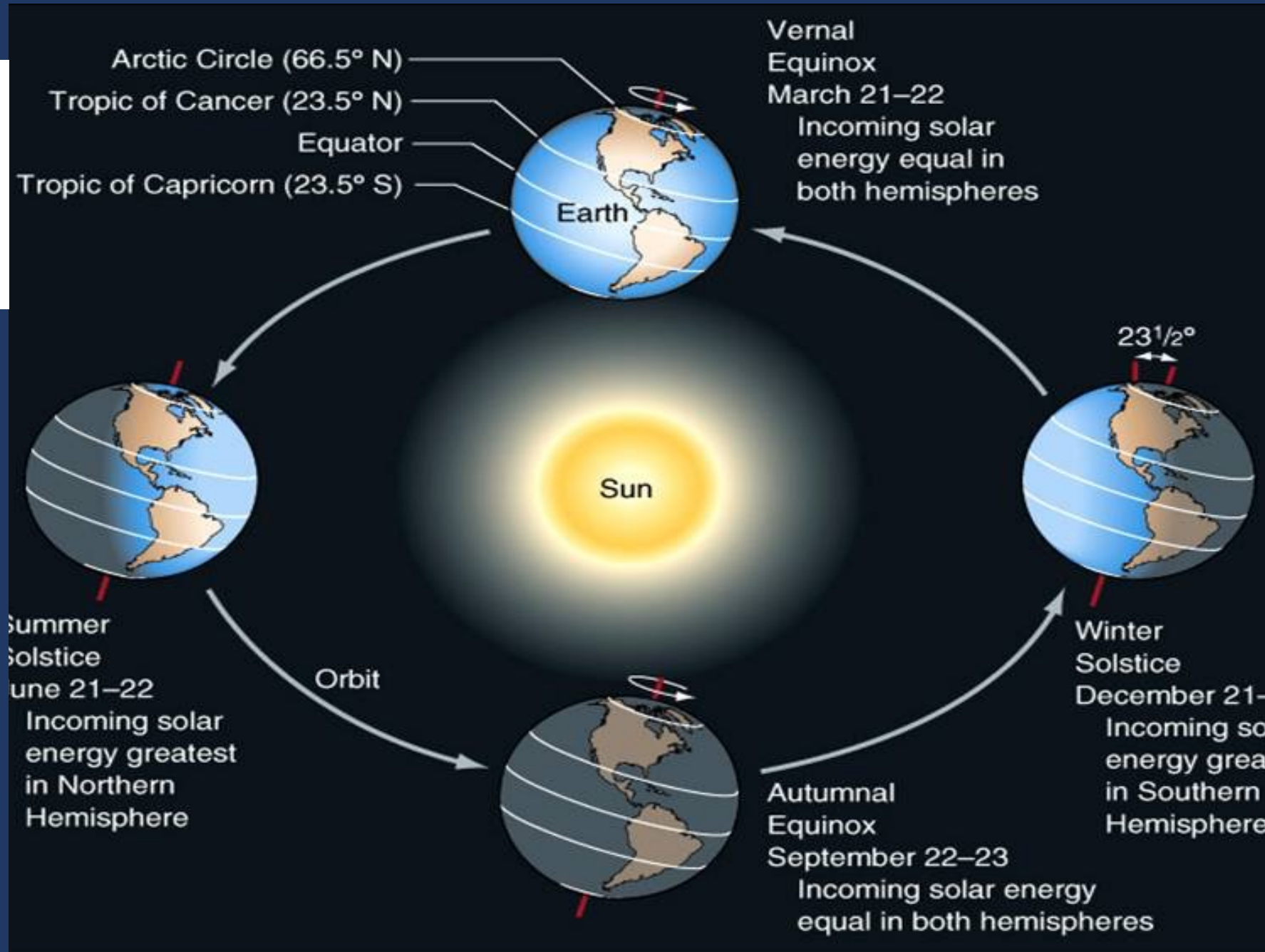
- I. Effect of Kinetic energy and Potential energy.
- II. Kepler's law of Planetary motion.
- III. Elliptical orbit of the Earth.

Select the correct statement(s) using the codes given below:

- a. I & II
- b. II & III
- c. II Only
- d. All of the above.

THE EARTH'S REVOLUTION

- Elliptical orbit
- Speed - 29.8 km/s
- 365 $\frac{1}{4}$ days - Leap Year

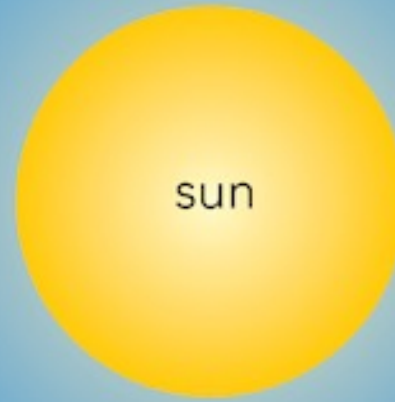
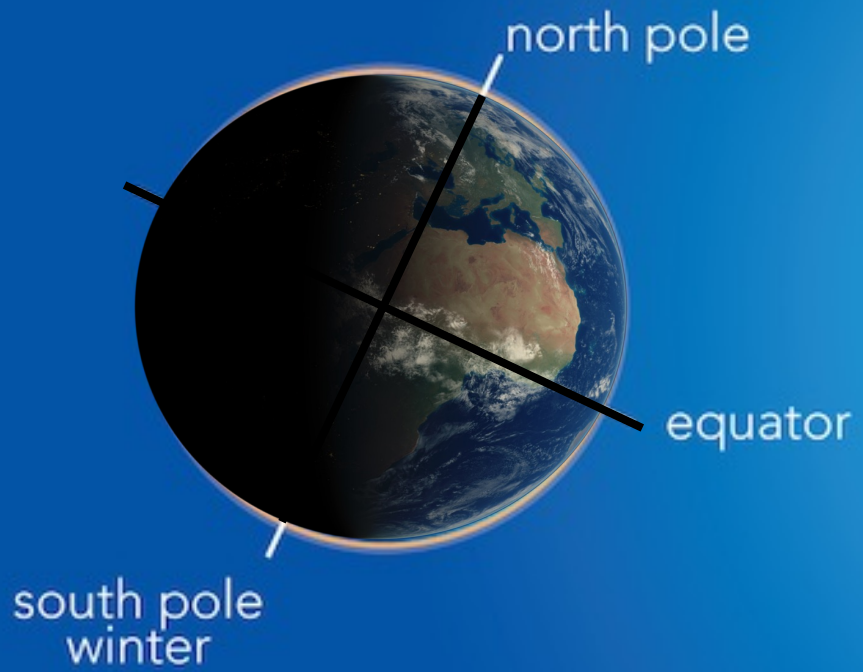


Kepler's Law of Planetary Motion:

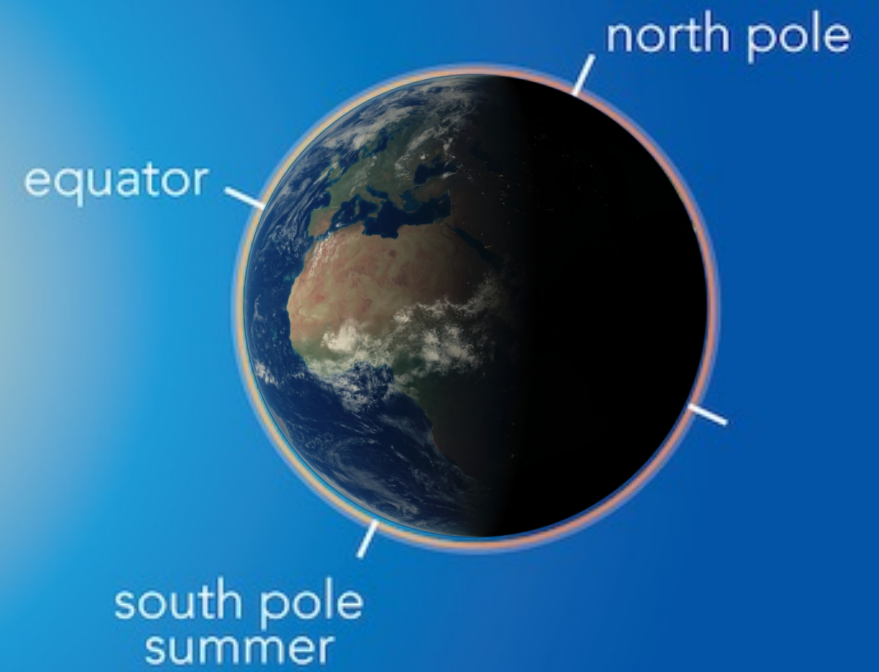
1 : a statement in astronomy: The orbit of each planet is an ellipse that has the sun at one focus.

2 : a statement in astronomy: The radius vector from the sun to each planet generates equal orbital areas in equal times.

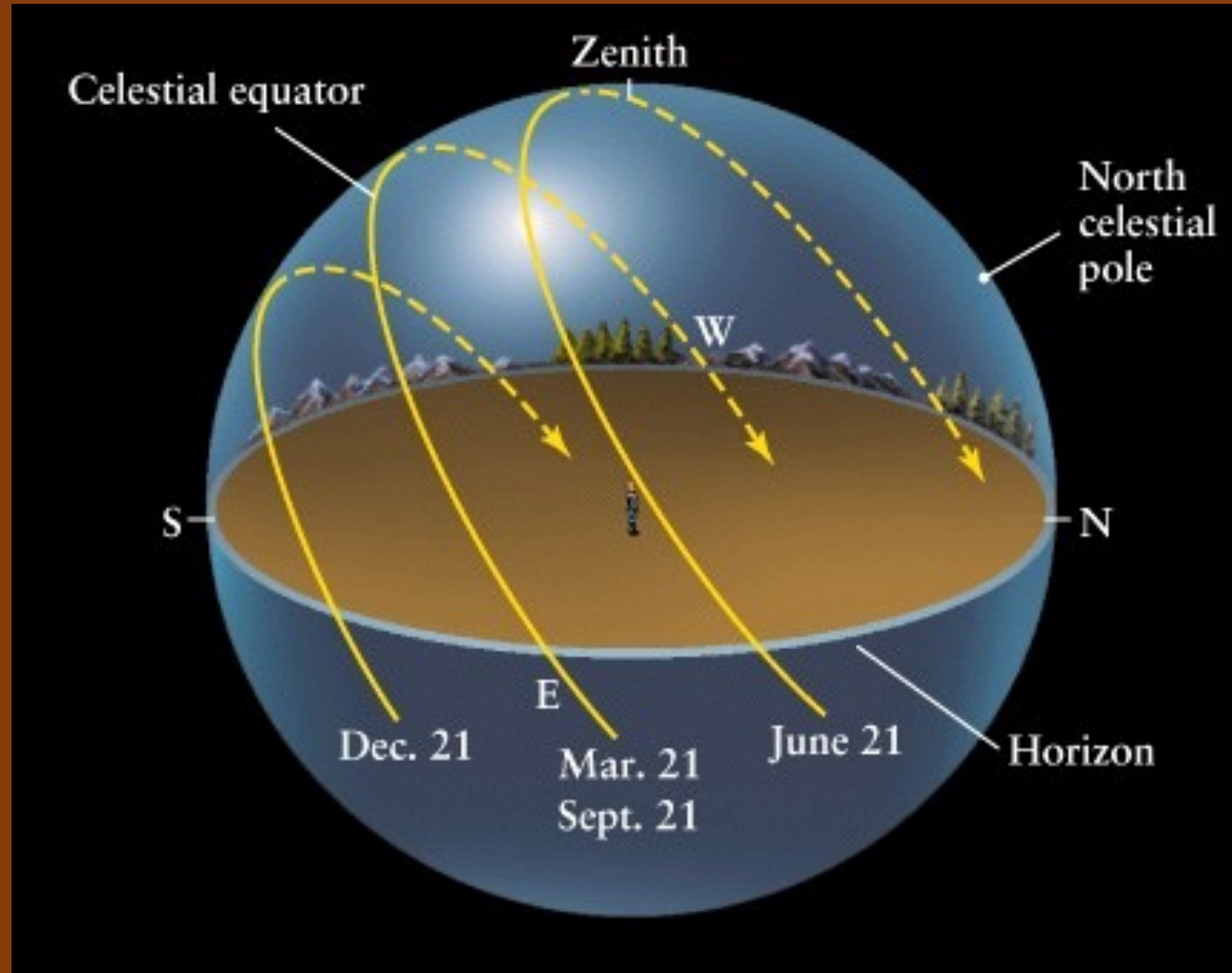
Summer Solstice

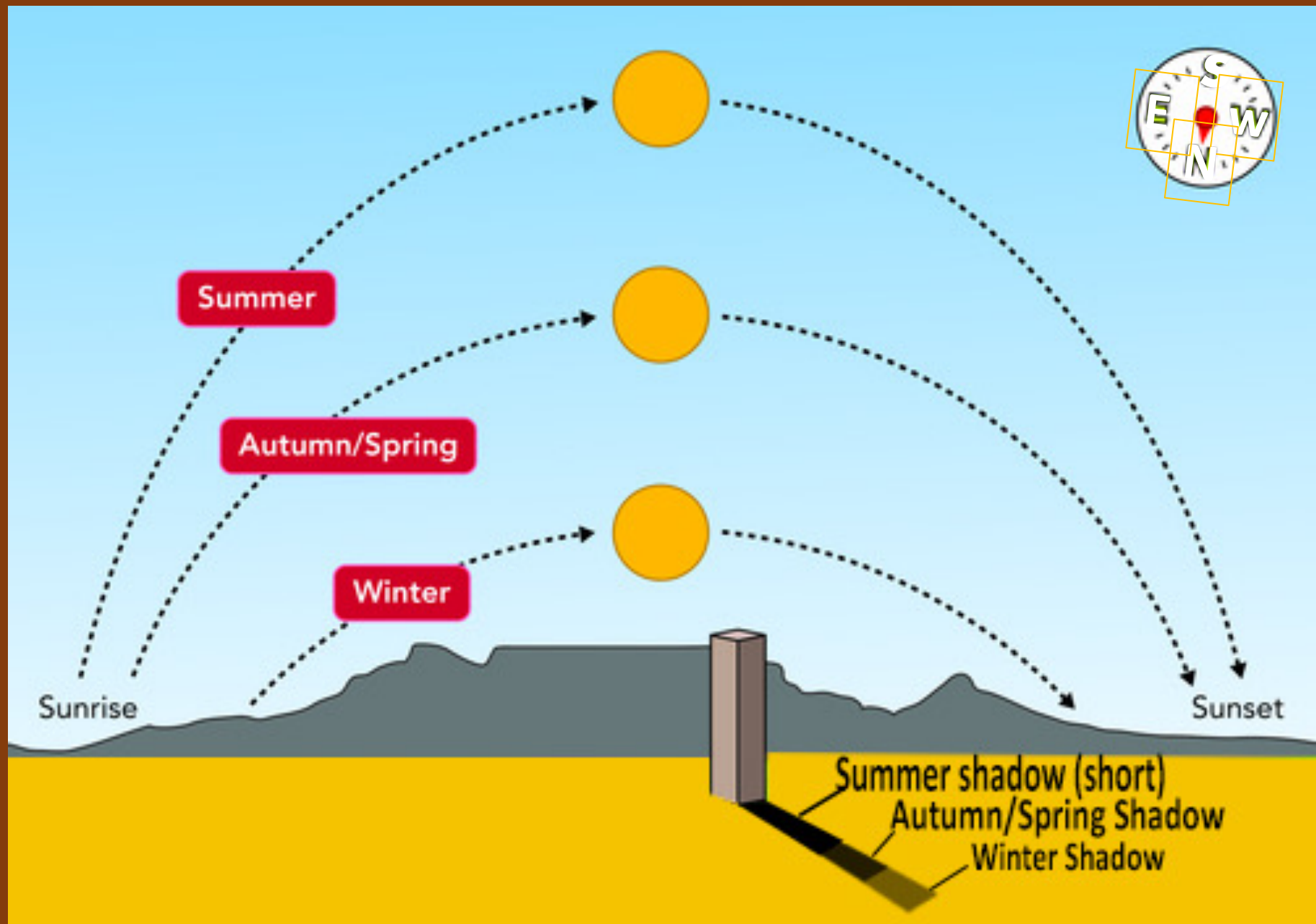


Winter Solstice



VARYING ALTITUDE OF MID-DAY SUN





Expected Question

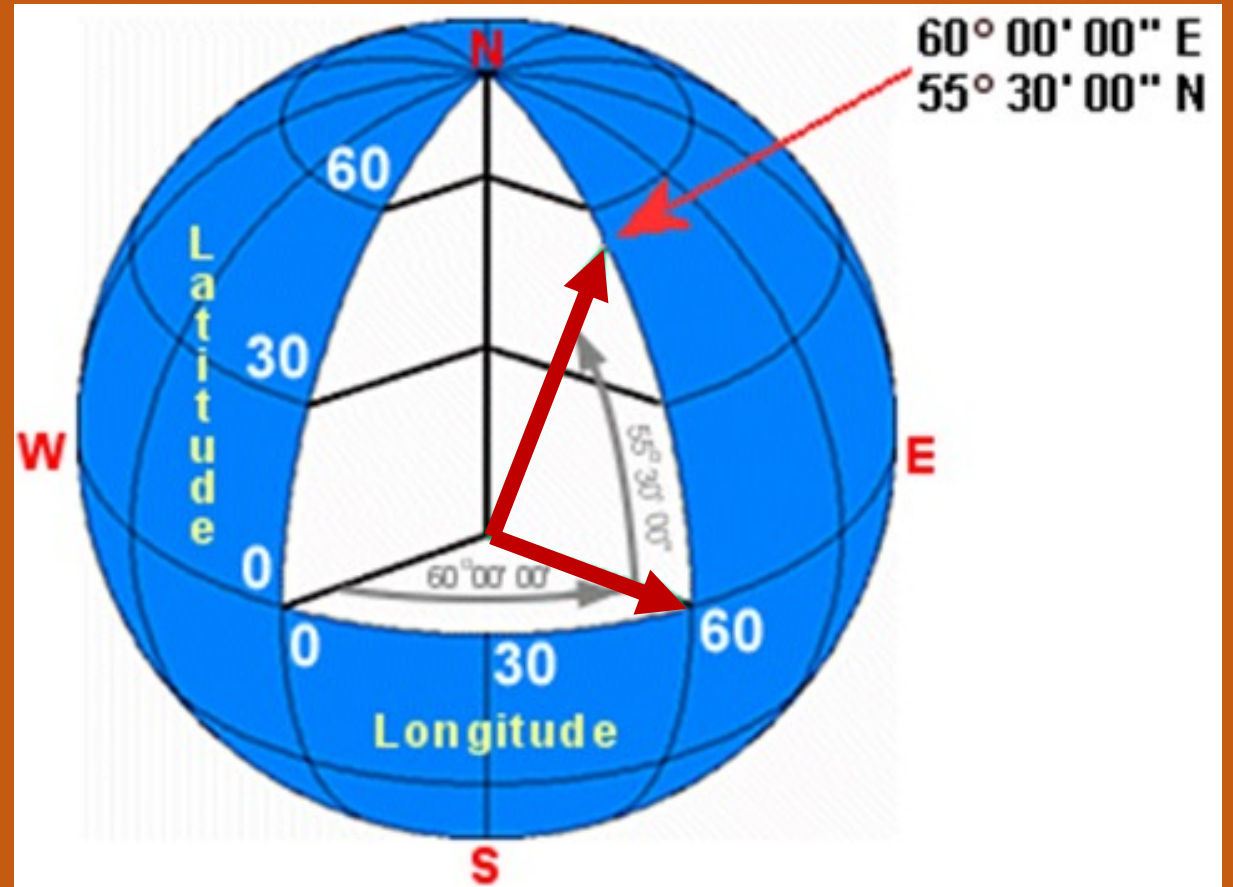
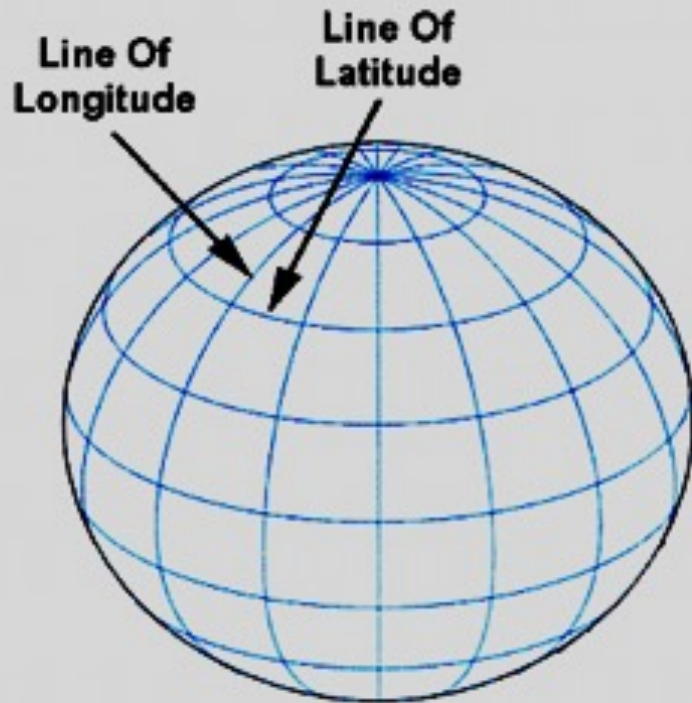
What is/are the major cause(s) for faster movement of the Earth in its Orbit in Perihelion and comparatively slower motion of the Earth in Aphelion:

- I. Effect of Kinetic energy and Potential energy.
- II. Kepler's law of Planetary motion.
- III. Elliptical orbit of the Earth.

Select the correct statement(s) using the codes given below:

- a. I & II
- b. II & III
- c. II Only
- d. All of the above.

LATITUDE AND LONGITUDE



Latitude:

Facts to Remember:

Parallel to each other and increases a little in the Poles

Each 1° = Approximately 111 km apart

Each 1° in Equator = 110.567 km

Each 1° in Tropics = 110.948 km

Each 1° in Poles = 111.699 km

Longitude:

Facts to Remember:

Not Parallel to each other and meet at poles

IST = GMT + 5 hrs.30 mins

Earth Rotates 24 hours to complete 360°



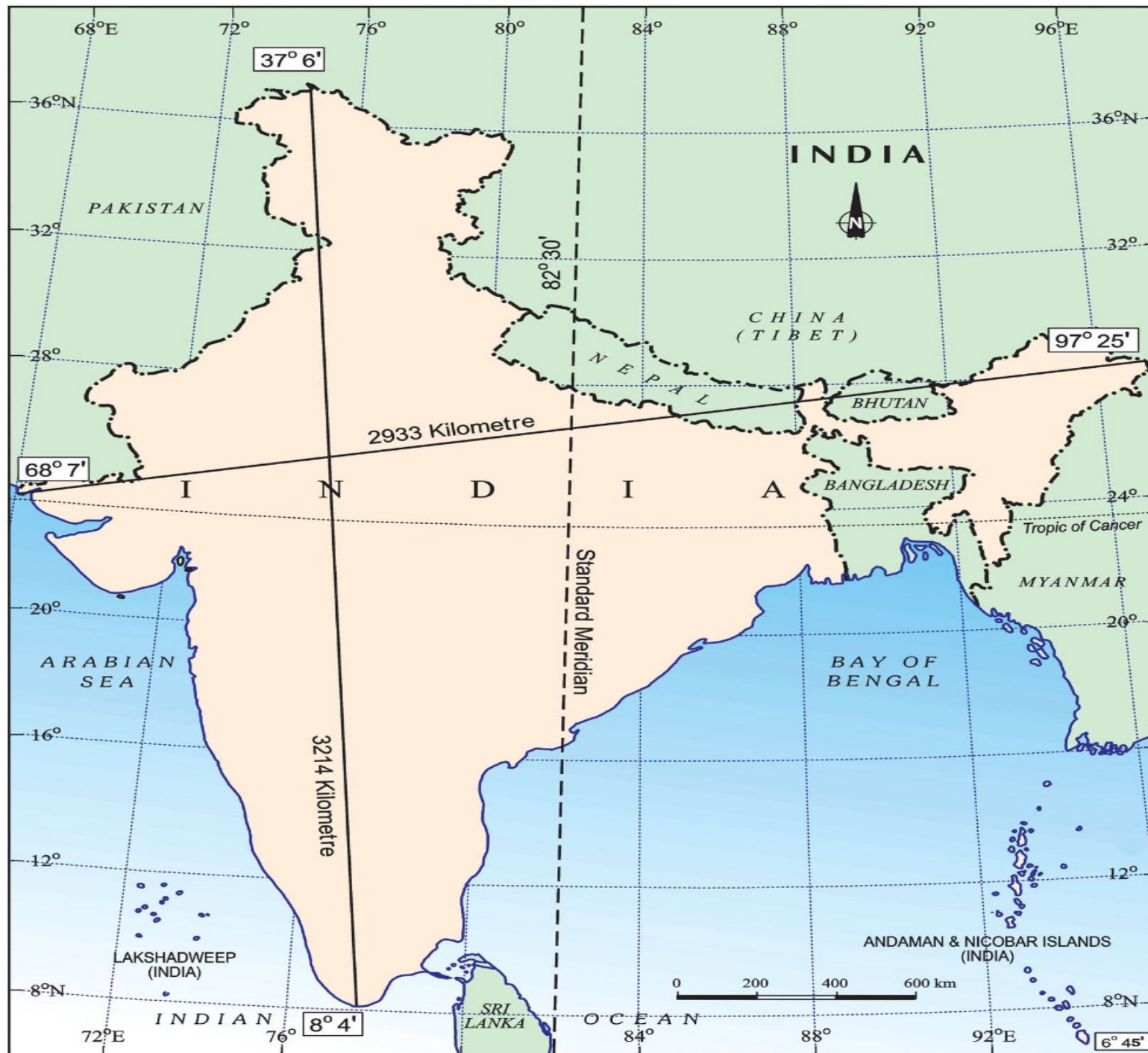
A ship sailing from the eastern extremity of the Aleutian Islands to Dutch crosses 180° meridian at 23.30 hrs on January 1, 1999. What time and date will be recorded by the captain of the ship in his diary after one-hour journey from the point of crossing of the meridian?

- 1. January 1, 0030 hrs**
- 2. January 2, 0030 hrs**
- 3. January 3, 0030 hrs**
- 4. January 4, 0030 hrs**



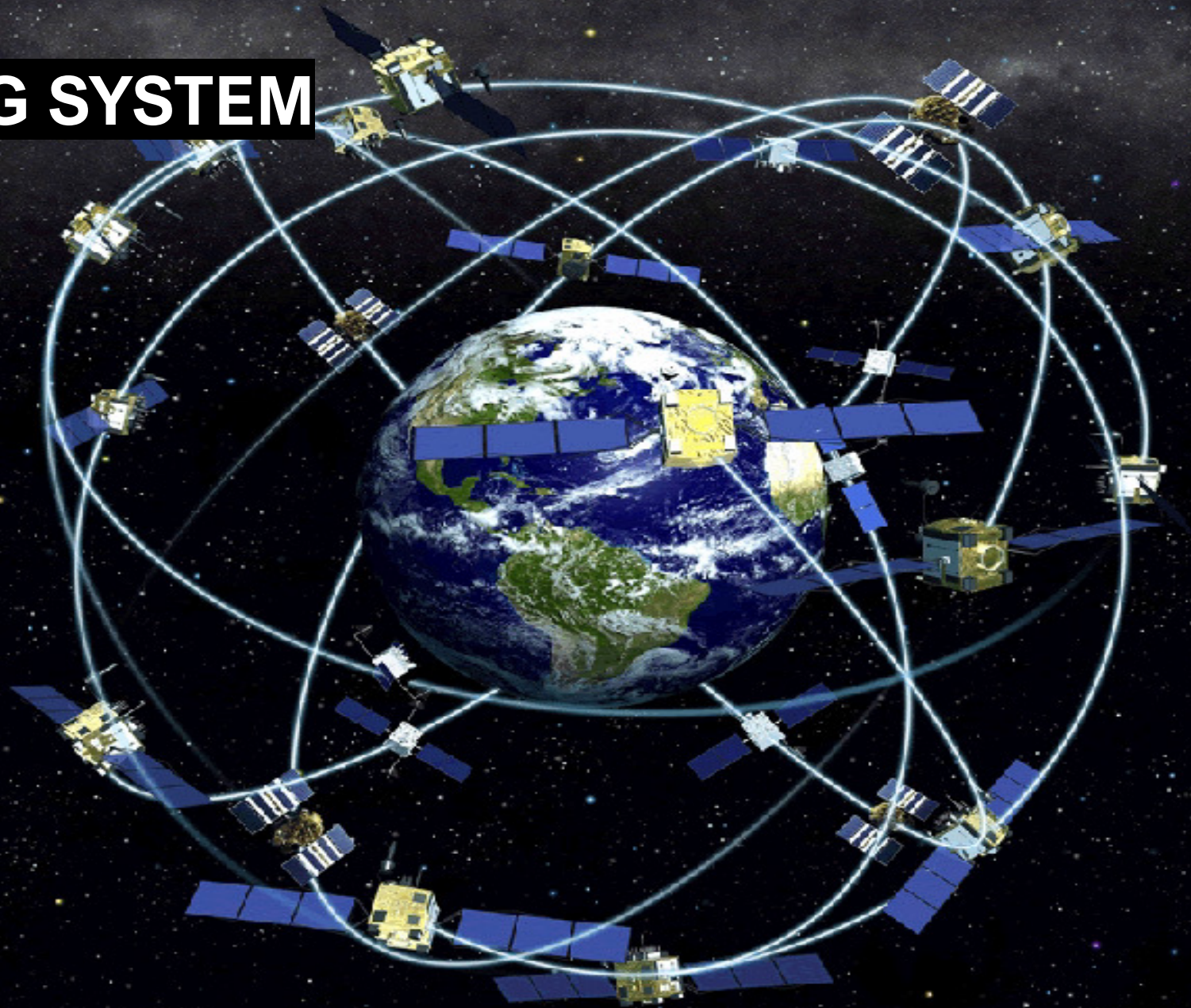
Taveuni Island, one of the most northerly islands of the Fijian archipelago

- Most countries adopt their standard time from the central meridian of their countries.
- In larger countries such as **Canada, U.S.A., China, and U.S.S.R**, it would be inconvenient to have single time zone. So these countries have multiple time zones.
- Both **Canada and U.S.A.** have **five time zones**—the Atlantic, Eastern, Central, Mountain and Pacific Time Zones. The difference between the local time of the Atlantic and Pacific coasts is nearly five hours.
- S.S.R had eleven time zones before its disintegration. **Russia** now has **nine time zones**.



GPS

GLOBAL POSITIONING SYSTEM



Sectors used in:

Internet of Things (IoT), Location based services, Emergency and security, Humanitarian services, Scientific research, Weather and Climate, Transportation, Agriculture, Fisheries, Civil engineering, Communication, Banking, Energy

Types

- GLONASS(Globalnaya Navigazionnaya Sputnikovaya Sistema)
- GALILEO(European Global Navigation Satellite System)
- INDIAN REGIONAL NAVIGATION SATELLITE SYSTEM (IRNSS)
- GAGAN(GPS Aided GEO Augmented Navigation)

Indian Regional Navigation Satellite System (IRNSS)

- 3 satellites will be put in geostationary orbit + 4 satellites in pairs in two inclined geosynchronous orbits
- Will need a special receiver equipment to use navigation data, standard GPS receiver will not work
- Each IRNSS satellite is equipped with rubidium atomic clocks, to keep precise time.
- . Standard Positioning Services, available to all users, and an encrypted service, provided only to authorized users
- ISRO have to launch at least four of the seven planned IRNSS satellites

Global Positioning System Aided Geo Augmented Navigation System (GAGAN)

- A joint effort by the ISRO & Airports Authority Of India (AAI) for civil aviation purposes
- Depends on GPS (American navigation system)
- India has become 4th nation after US, Europe & Japan to have inter-operable Satellite Based Augmentation System (SBAS) & 1st in the world to serve the equatorial region
- GAGAN system corrects any anomalies in the position data and gives accurate routes, landing guidance and time saving information to the pilots
- System would be available for the member states of the South Asian Association for Regional Cooperation (SAARC)
- Only those aircraft that are fitted with satellite-based wide area augmentation system (SBAS) will be able to use the new technology

GSAT 16(Geosynchronous Satellite)

- INSAT-3E is a communication satellite that powers DD & private TV channels, internet & radio signals.
- INSAT-3E is getting old and outdated, even stopped working in March 2014, after serving for almost a decade, hence need to be replaced with GSAT-16
- GSAT 16 is configured to carry a total of 48 communication transponders, the largest number of transponders carried by a communication satellite developed by ISRO so far
- The designed on-orbit operational life of GSAT-16 is 12 years.
- Placed in Geosynchronous Transfer Orbit at 55 degrees East longitude by European Ariane-5 launcher

GSAT 6

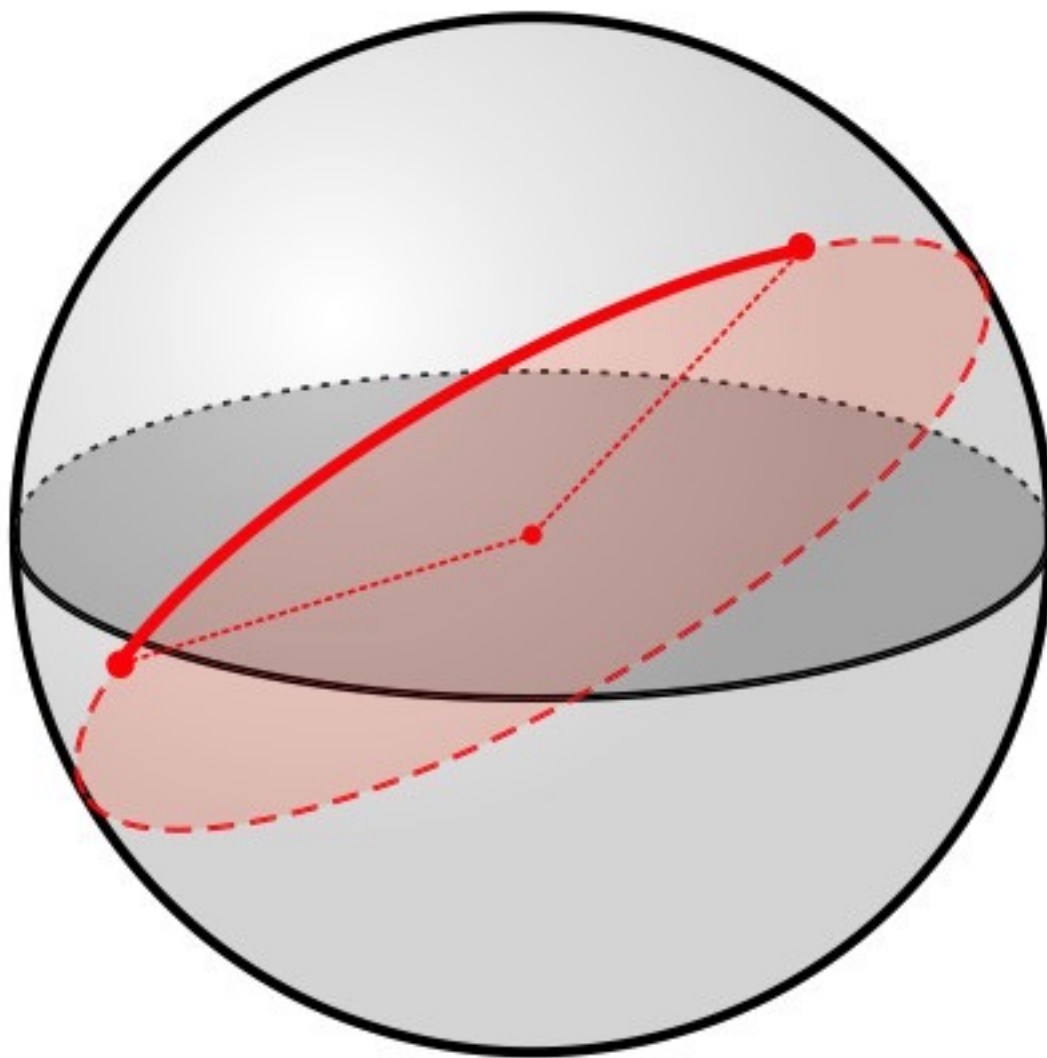
- It is aimed at primarily benefiting the country's strategic and social applications
- Has life period of nine years & will provide S-band communication services in the country
- It includes a first-of-its-kind S-Band antenna with a diameter of six meter. This is the largest antenna ISRO has ever made for a satellite.
- It will offer a Satellite Digital Multimedia Broadcasting (S-band) service, via mobile phones and mobile video/audio receivers for vehicles.

ASTROSAT

- India's 1st dedicated astronomy multi-wavelength satellite, aimed at studying distant celestial objects
- ASTROSAT will observe universe in the optical, Ultraviolet, low and high energy X-ray regions of the electromagnetic spectrum
- 1st mission to be operated as a space observatory by ISRO

Scientific objectives of ASTROSAT

- To understand high energy processes in binary star systems containing neutron stars and black holes
- Estimate magnetic fields of neutron stars
- Study star birth regions and high energy processes in star systems lying beyond our galaxy
- Detect new briefly bright X-ray sources in the sky
- Perform a limited deep field survey of the Universe in the Ultraviolet region

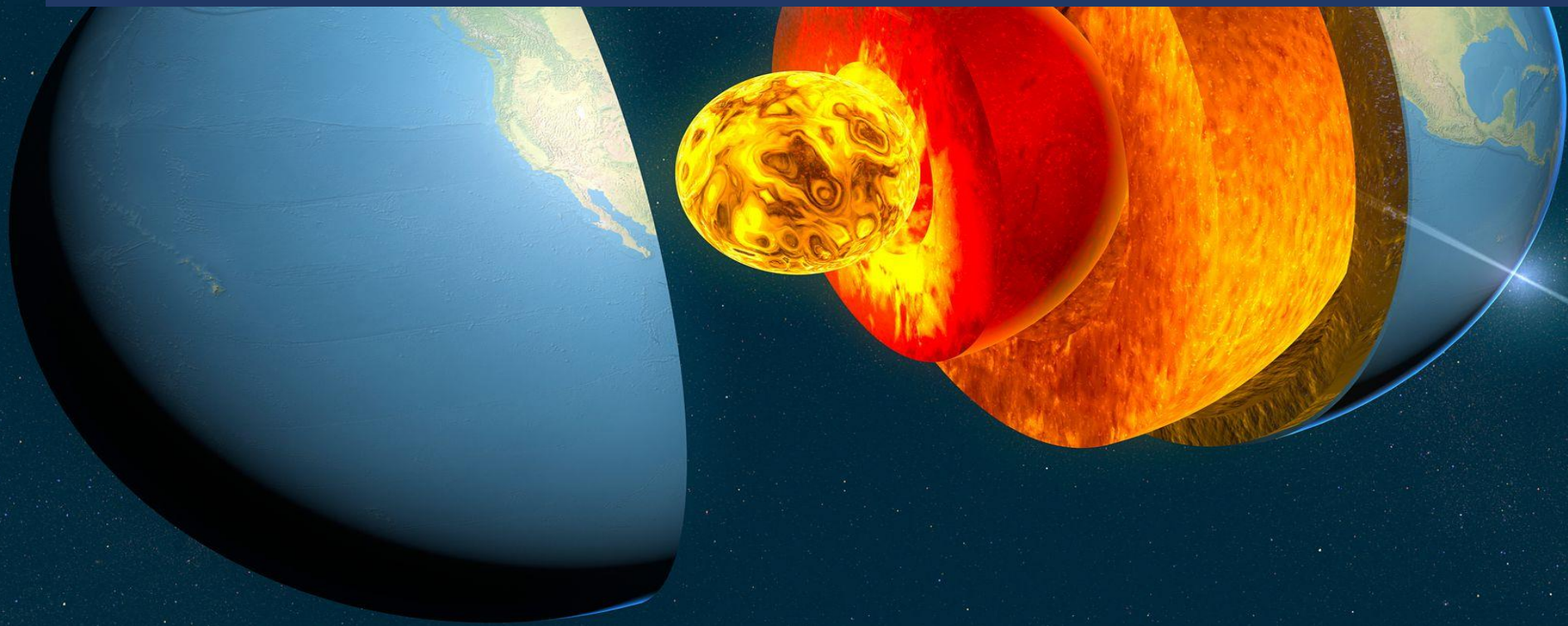


Test your Understandings

Suppose, You make a call from London on 20th December at 11 AM to your mother who is in Delhi. Then, at what time will she receive your call:

- a. 20th December 04:30 AM
- b. 19th December 11:00 PM
- c. 20th December 04:30 PM
- d. 19th December 11:00 AM

EARTH'S INTERIOR AND MATERIALS OF THE EARTH'S CRUST



EARTH'S FOUR SPHERES

Lithosphere – solid earth



Atmosphere – gases (the air)

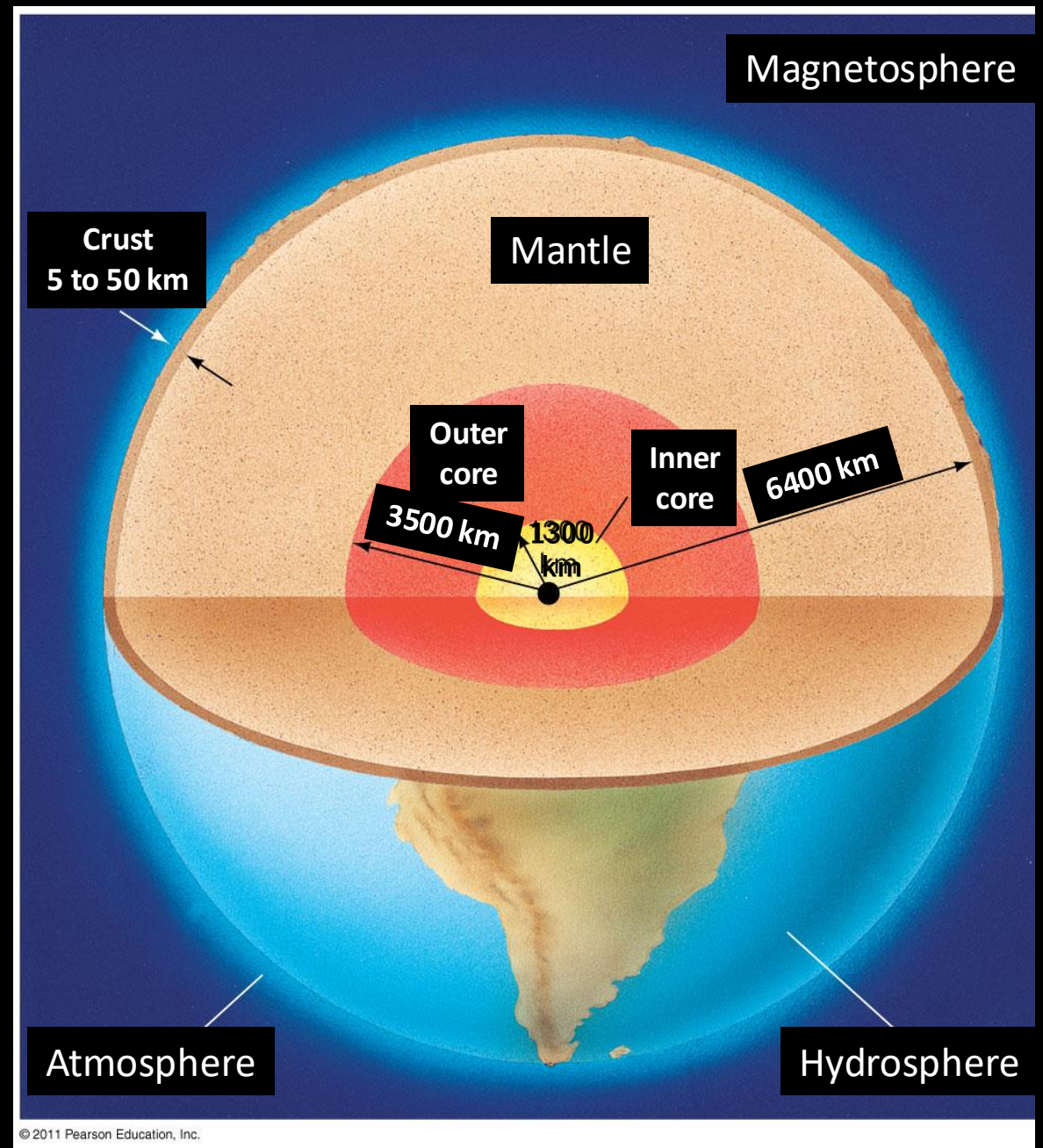
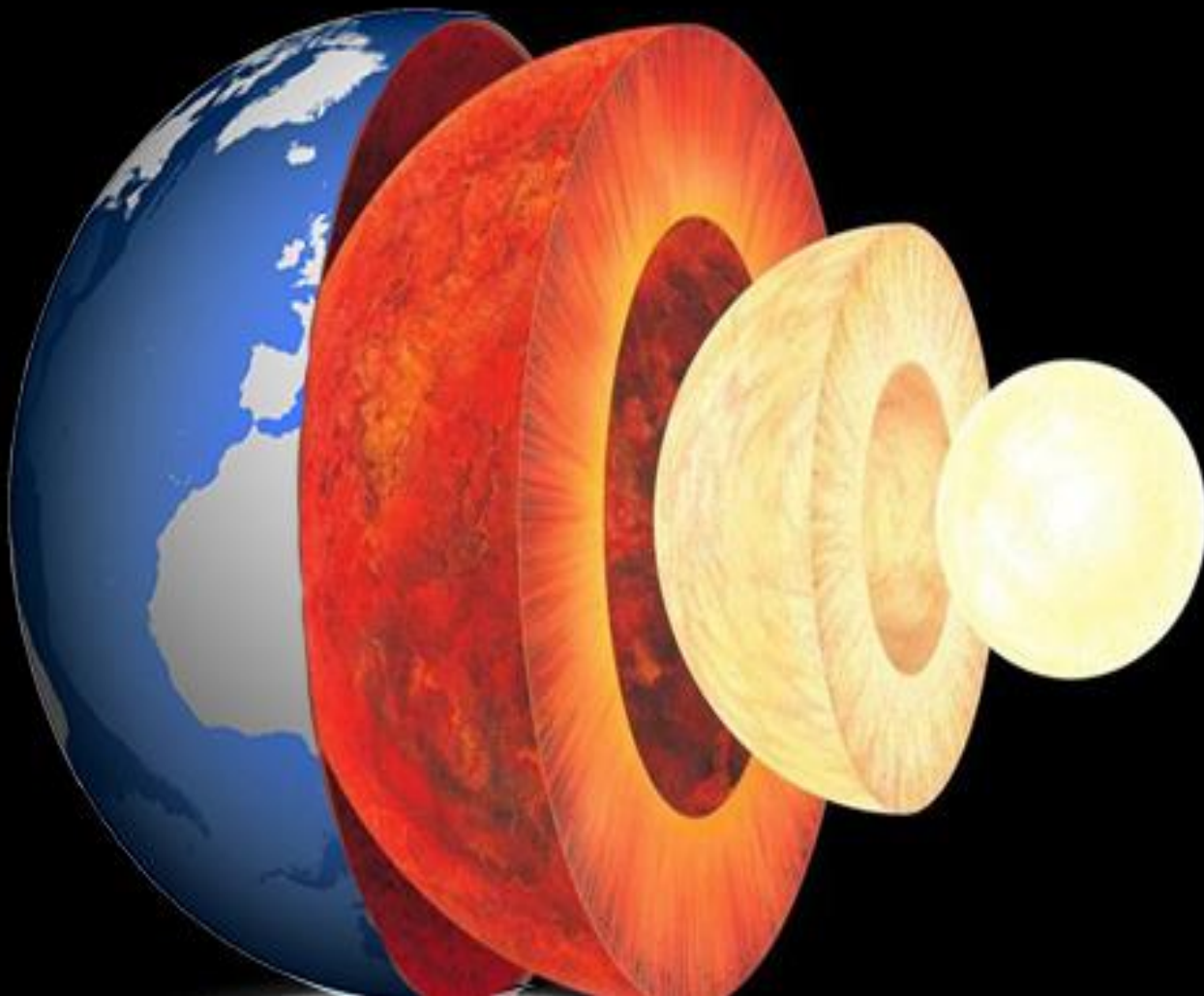


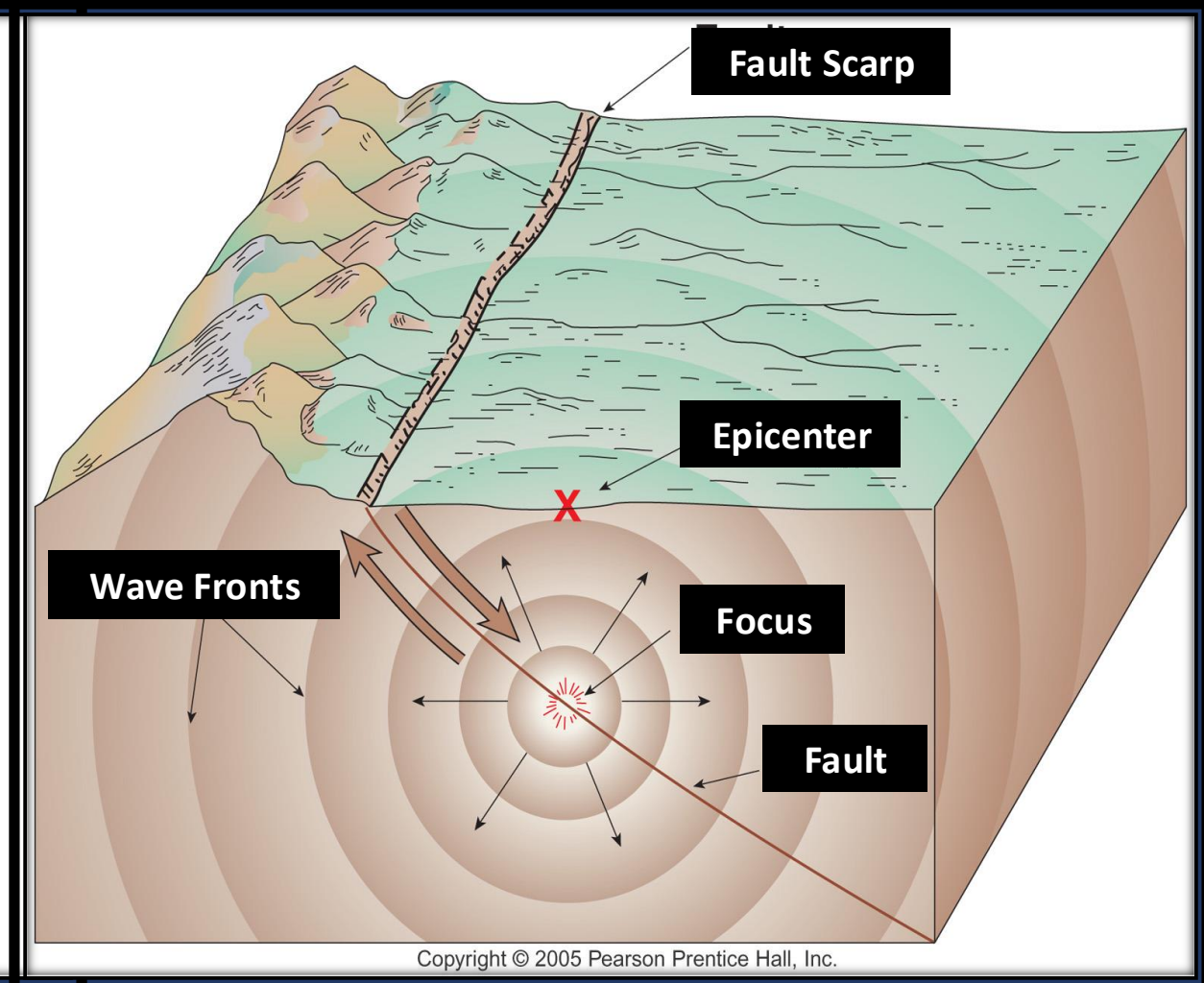
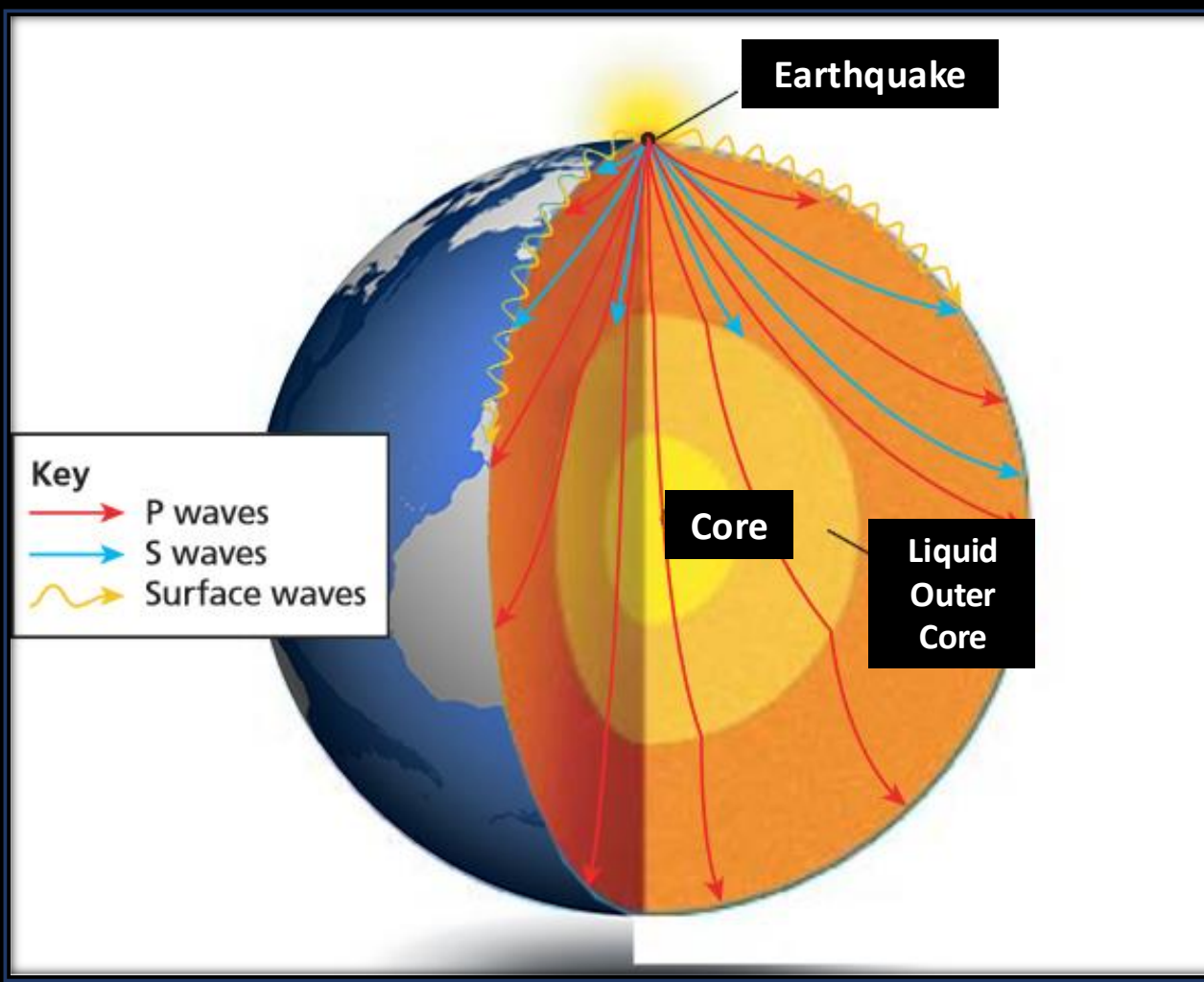
Hydrosphere – all water

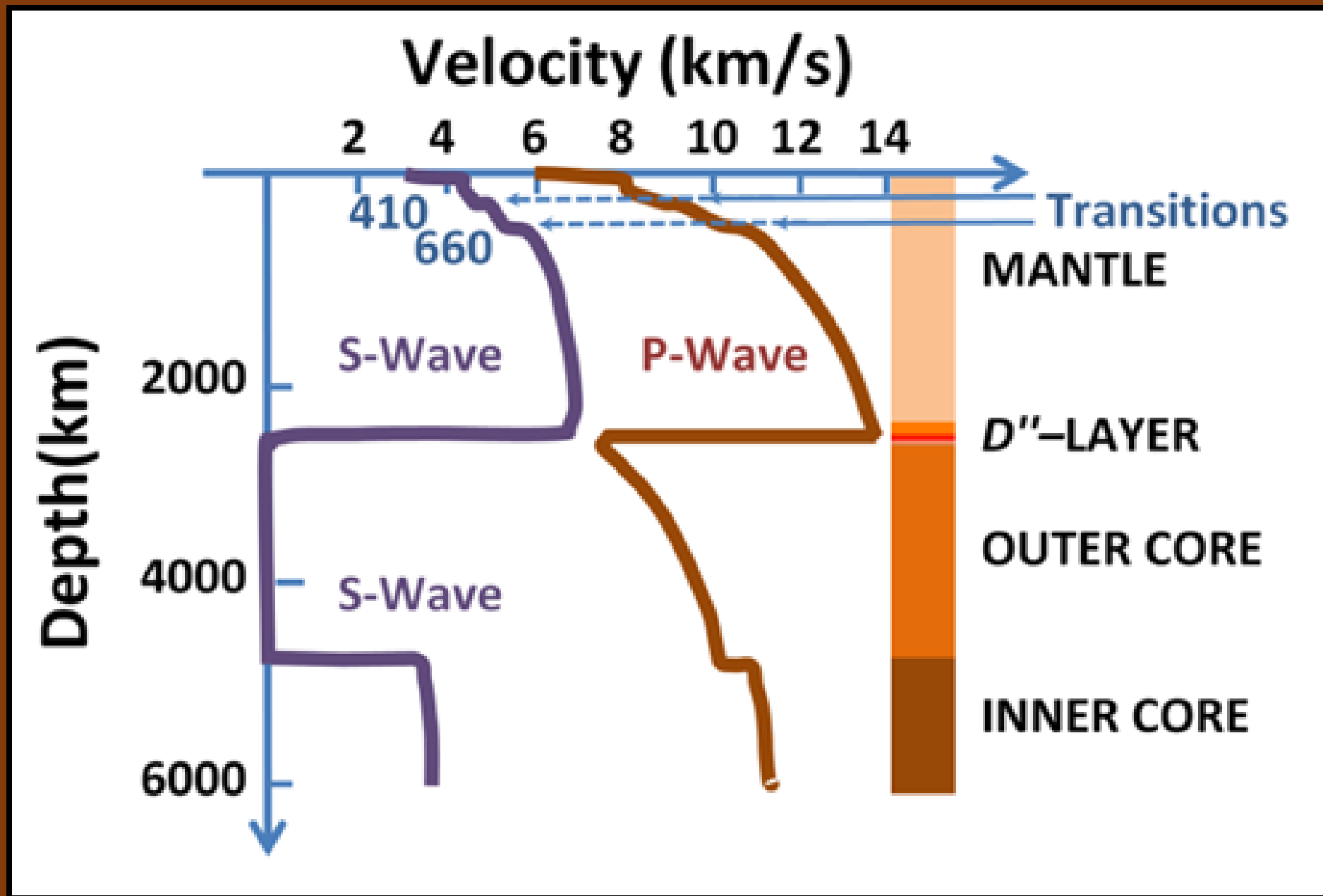


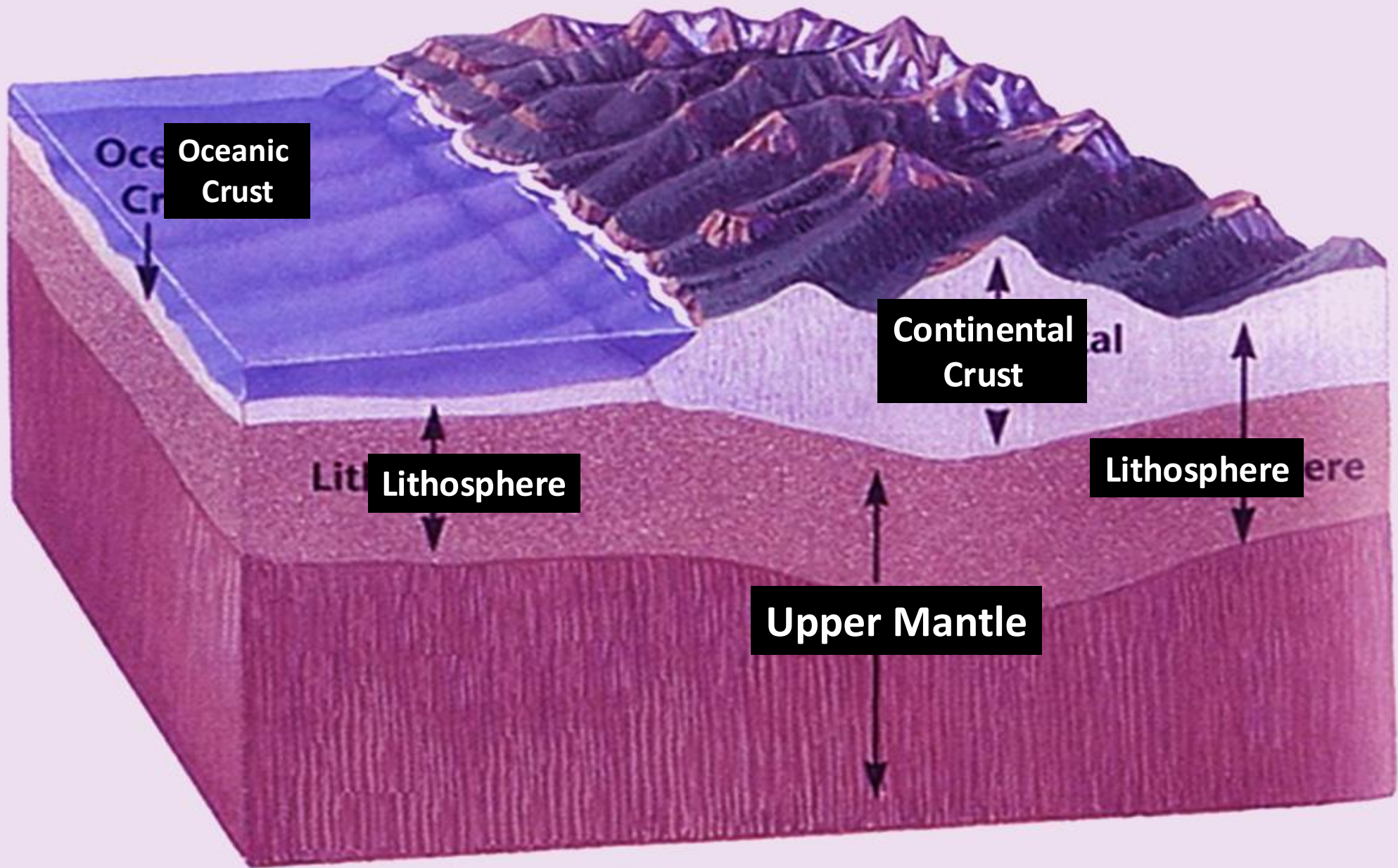
Biosphere – all life











CRUST:

- 5-30 km in case of the oceanic crust and as 50-70 km in case of the continental crust.
- 0.5-1.0 per cent of the earth's volume and less than 1 per cent of Earth's mass.
- The continents are composed of lighter silicates — **silica + aluminium** (also called **sial**) while the oceans have the heavier silicates — **silica + magnesium** (also called **sima**)
- The continental crust is composed of lighter (**felsic**) **sodium potassium aluminium silicate** rocks, like **granite**.
- The oceanic crust, on the other hand, is composed of dense (**mafic**) **iron magnesium silicate** igneous rocks, like **basalt**.
- Find the most abundant elements

Lithosphere

- ❖ rigid outer part of the earth with thickness varying between 10-200 km.
- ❖ **crust and the upper part of the mantle.**
- ❖ The lithosphere is broken into **tectonic plates (lithospheric plates)**

Asthenosphere

- upper portion of the mantle is called as asthenosphere (astheno means weak).
- **just below the lithosphere** extending up to **80-200 km.**
- **main source of magma, aid in plate tectonic movement and isostatic adjustments**

The Mantle

- ❑ **83 per cent of the earth's volume and holds 67% of the earth's mass.**
- ❑ **composed of silicate rocks that are rich in iron and magnesium**
- ❑ **High-pressure conditions ought to inhibit seismicity in the mantle.**
- ❑ **Find the Elements**

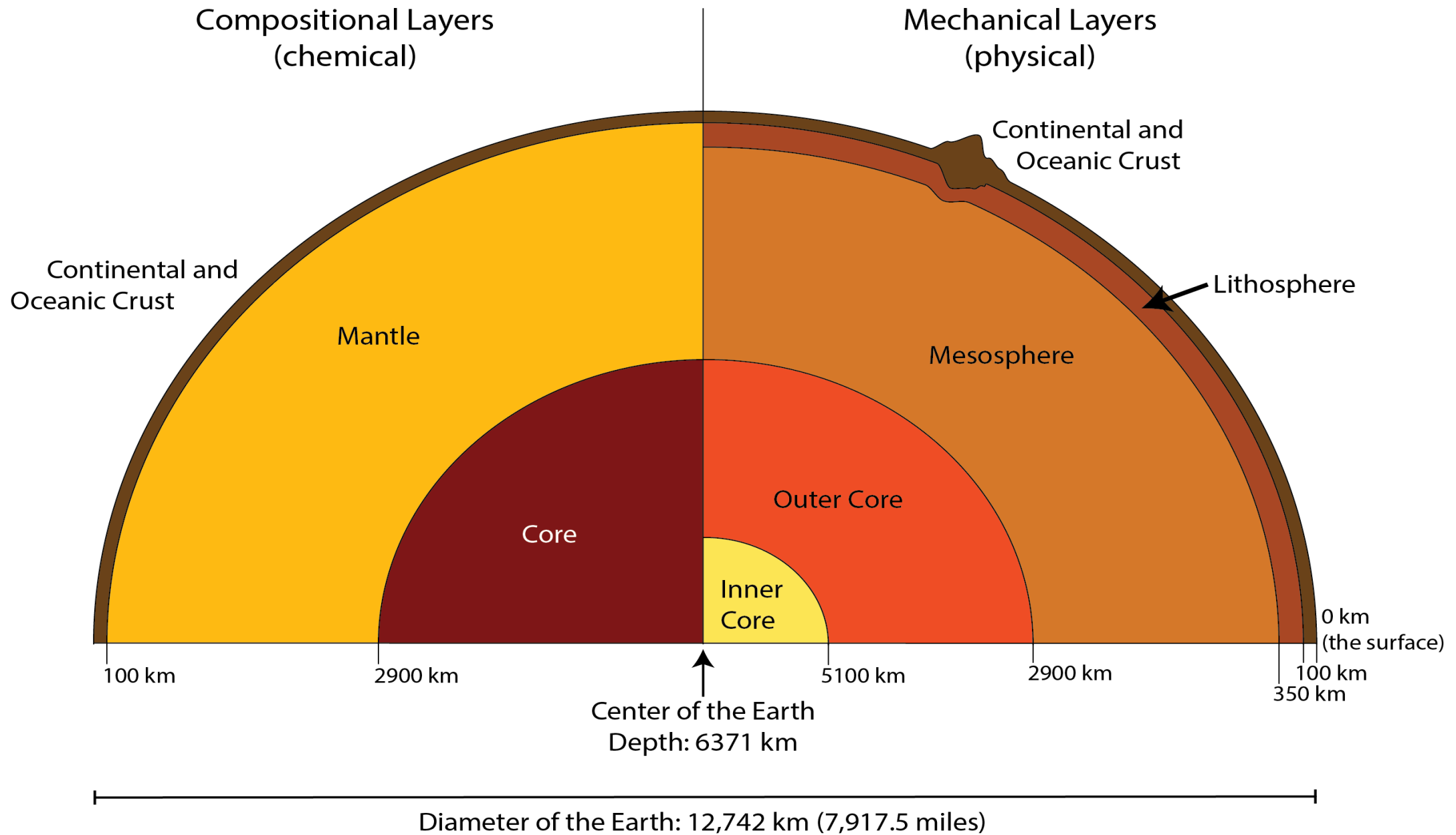
The Outer Core

- **iron mixed with nickel (nife)** and trace amounts of lighter elements.
- Dynamo theory suggests that **convection in the outer core, combined with the Coriolis effect**, gives rise to **Earth's magnetic field**.

The Inner Core

- composed primarily of **iron (80%) and some nickel (nife)**.
- At 6000°C, this iron core is as hot as the Sun's surface, but the **crushing pressure caused by gravity prevents it from becoming liquid**.

Two different views of the interior of the Earth



Expected Question

Consider the following statements with reference to the Earth's crust:

- I. The crust is the outermost solid part of the earth.
- II. The continental crust is mainly formed by basaltic rocks.
- III. The oceanic crust are mainly formed by granitic rocks.

Which of the following statements is/are NOT correct:

- a. I Only
- b. II and III
- c. I and III
- d. I, II and III

Conorod discontinuity – between
upper & lower crust

Mohorovicc
discontinuity –
between lower
crust & upper
mantle

Repiti discontinuity –
between upper &
lower Mantle

Guttenberg
discontinuity –
between lower
Mantle & outer Core

Lehmann discontinuity
– between outer &
inner core

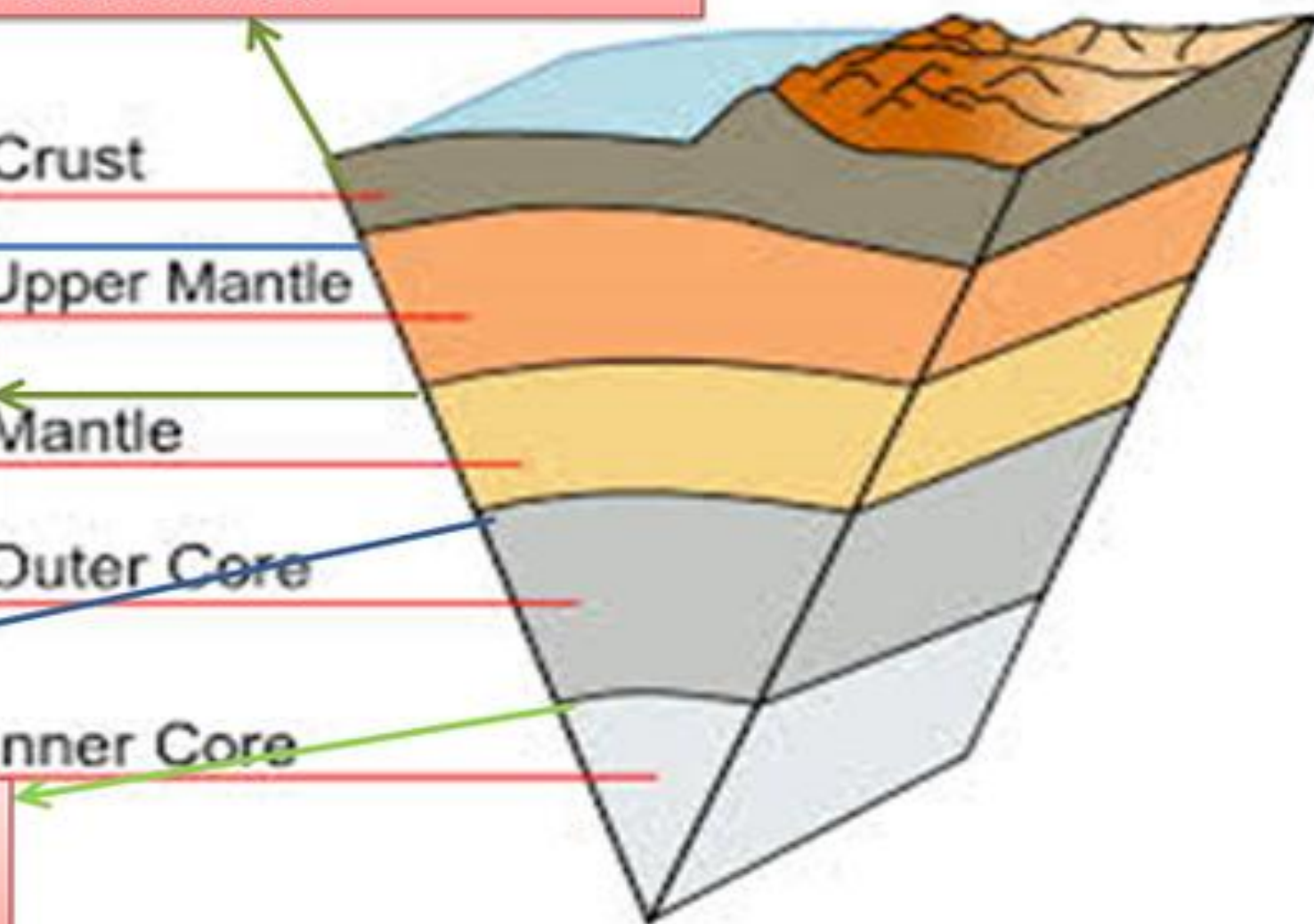
Crust

Upper Mantle

Mantle

Outer Core

Inner Core



CONTINENTAL DRIFT THEORY



CONTINENTAL DRIFT THEORY



225 million years ago



150 million years ago



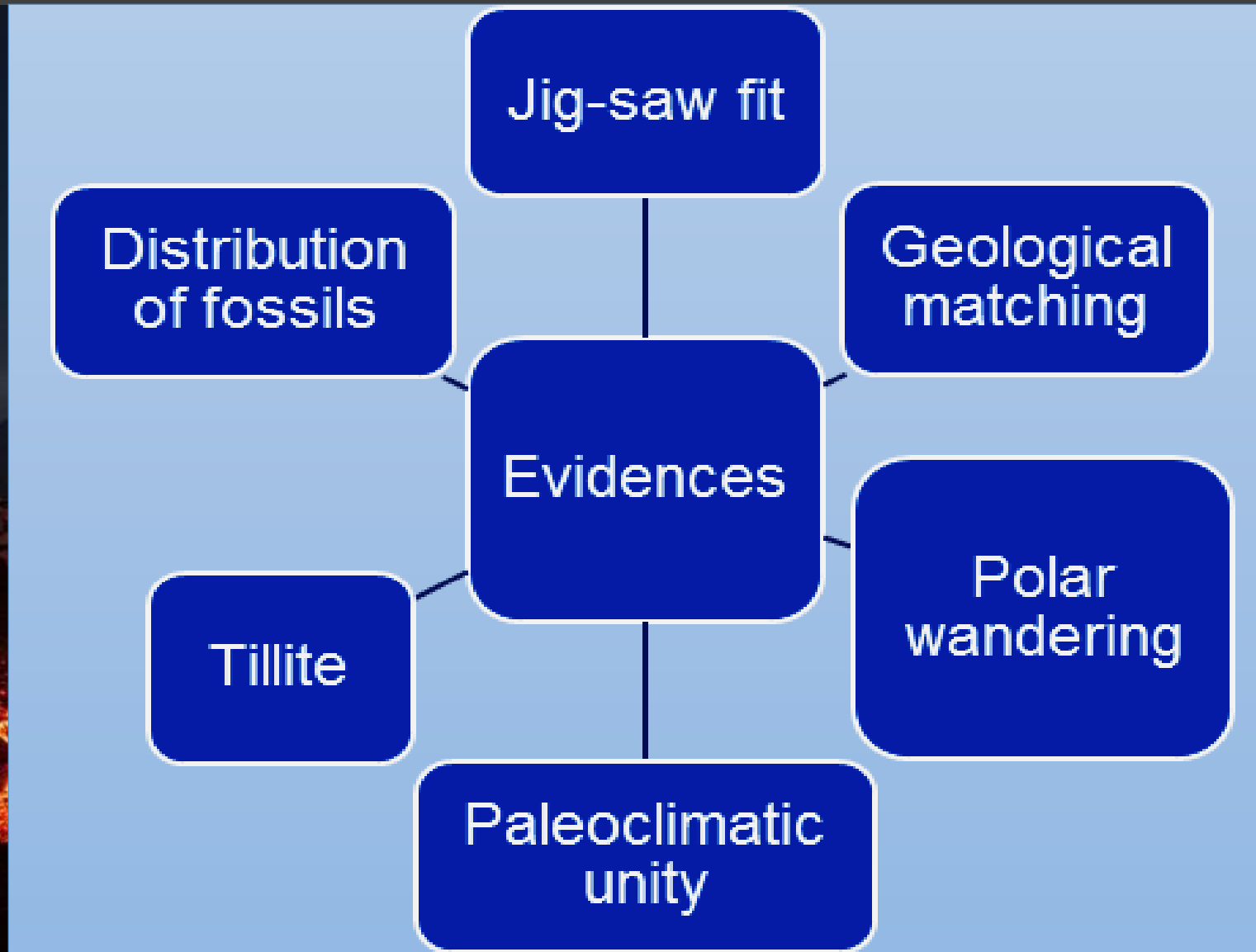
100 million years ago

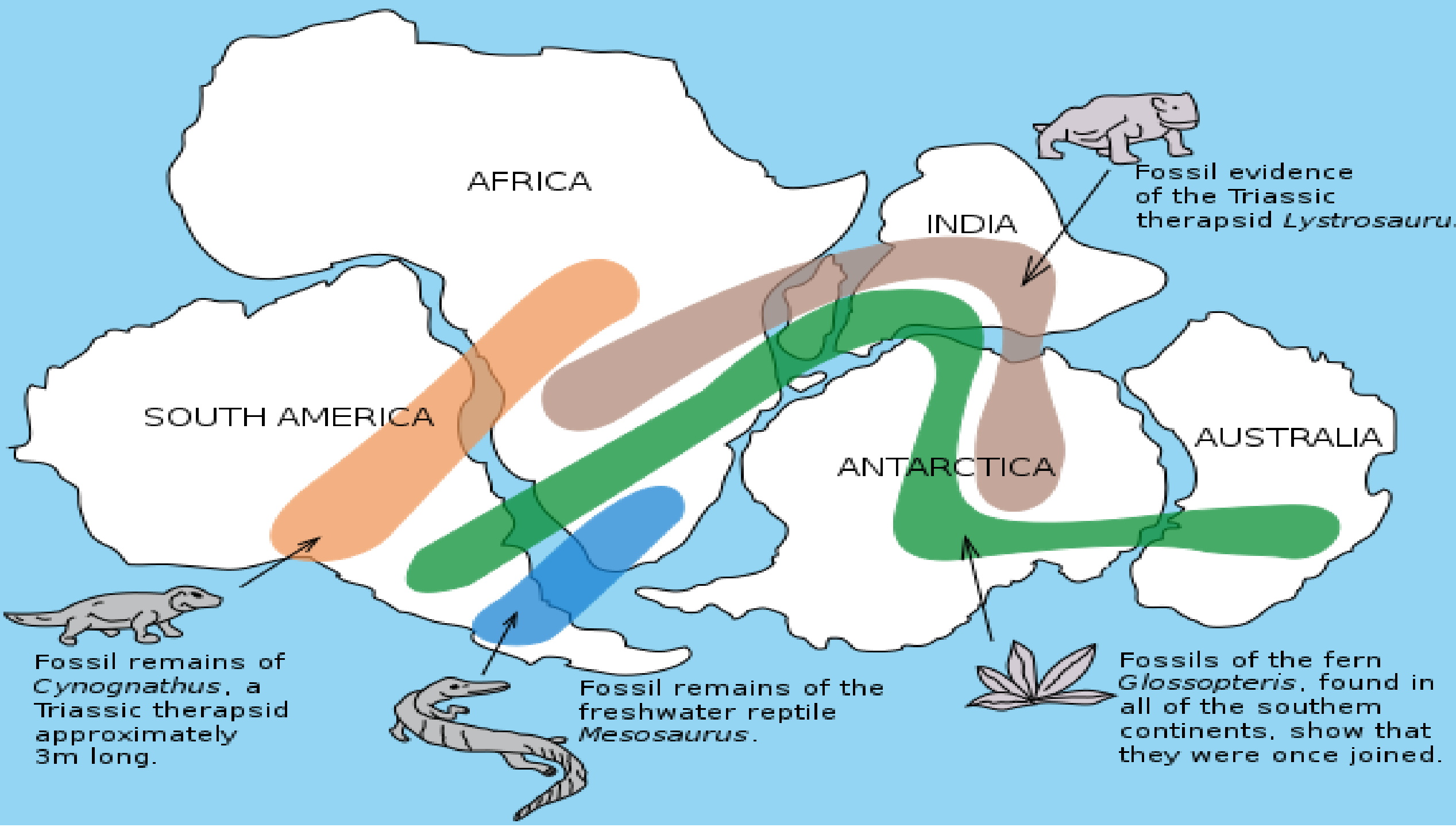


Earth today

© 2007 EB Inc.

EVIDENCES OF CDT





AFRICA

INDIA

SOUTH AMERICA

ANTARCTICA

AUSTRALIA

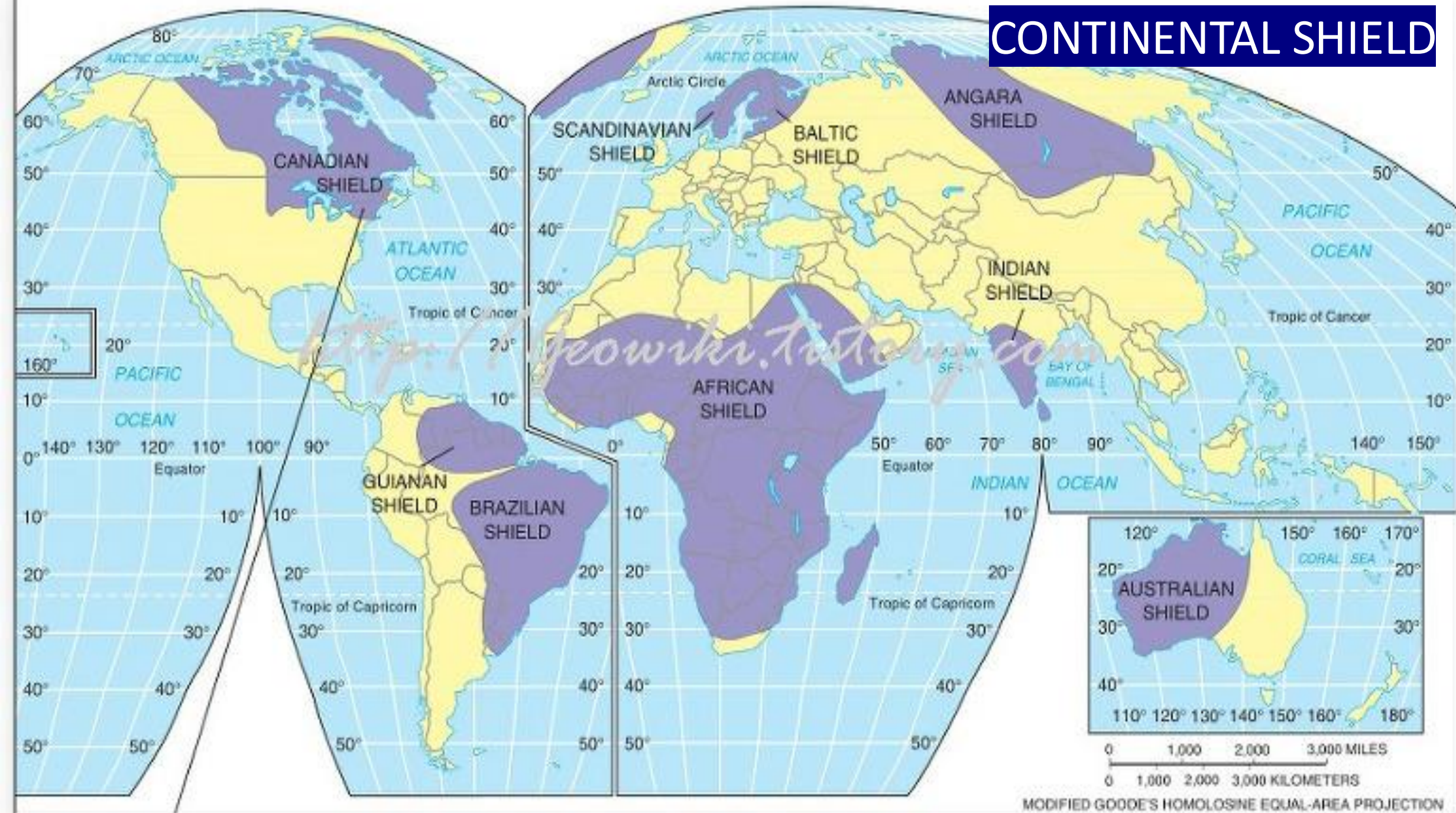
Fossil evidence of the Triassic therapsid *Lystrosaurus*.

Fossil remains of *Cynognathus*, a Triassic therapsid approximately 3m long.

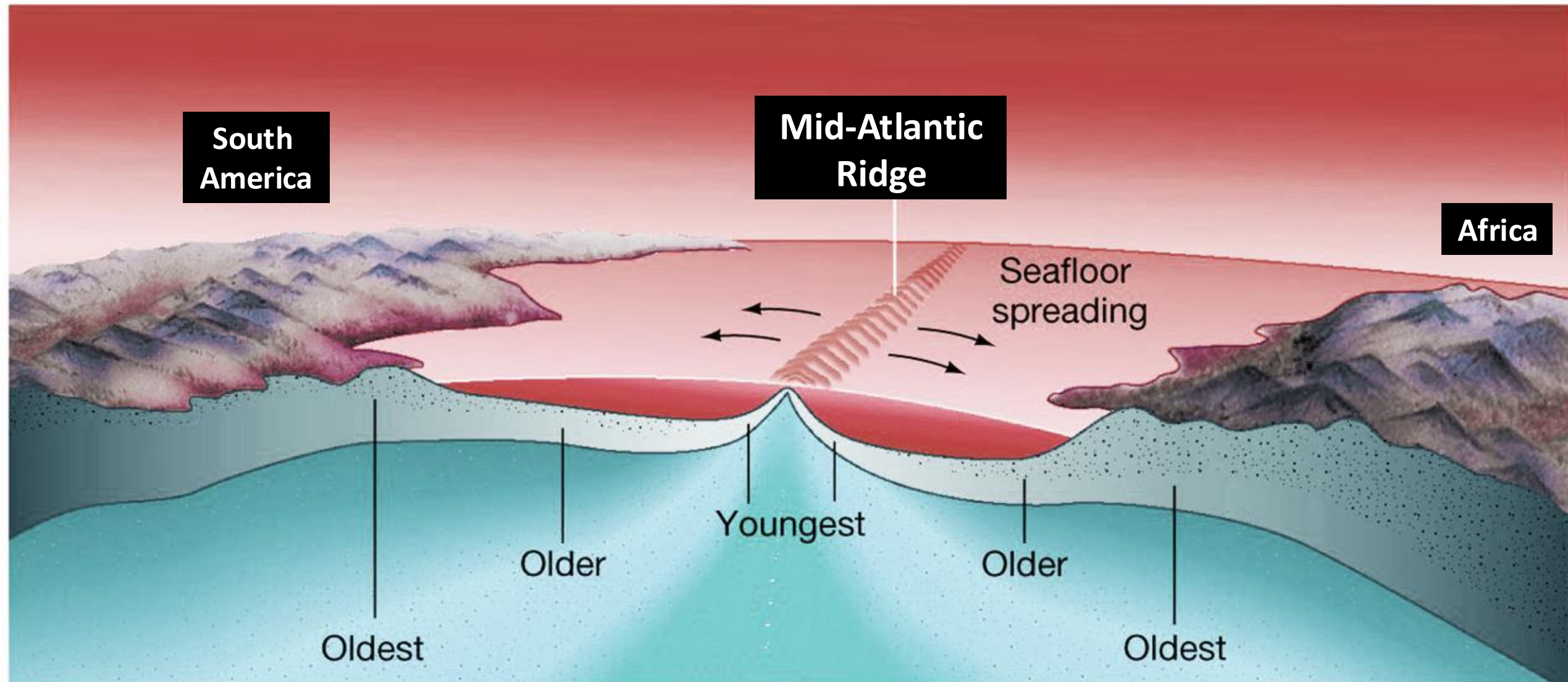
Fossil remains of the freshwater reptile *Mesosaurus*.

Fossils of the fern *Glossopteris*, found in all of the southern continents, show that they were once joined.

CONTINENTAL SHIELD



SEA FLOOR SPREADING



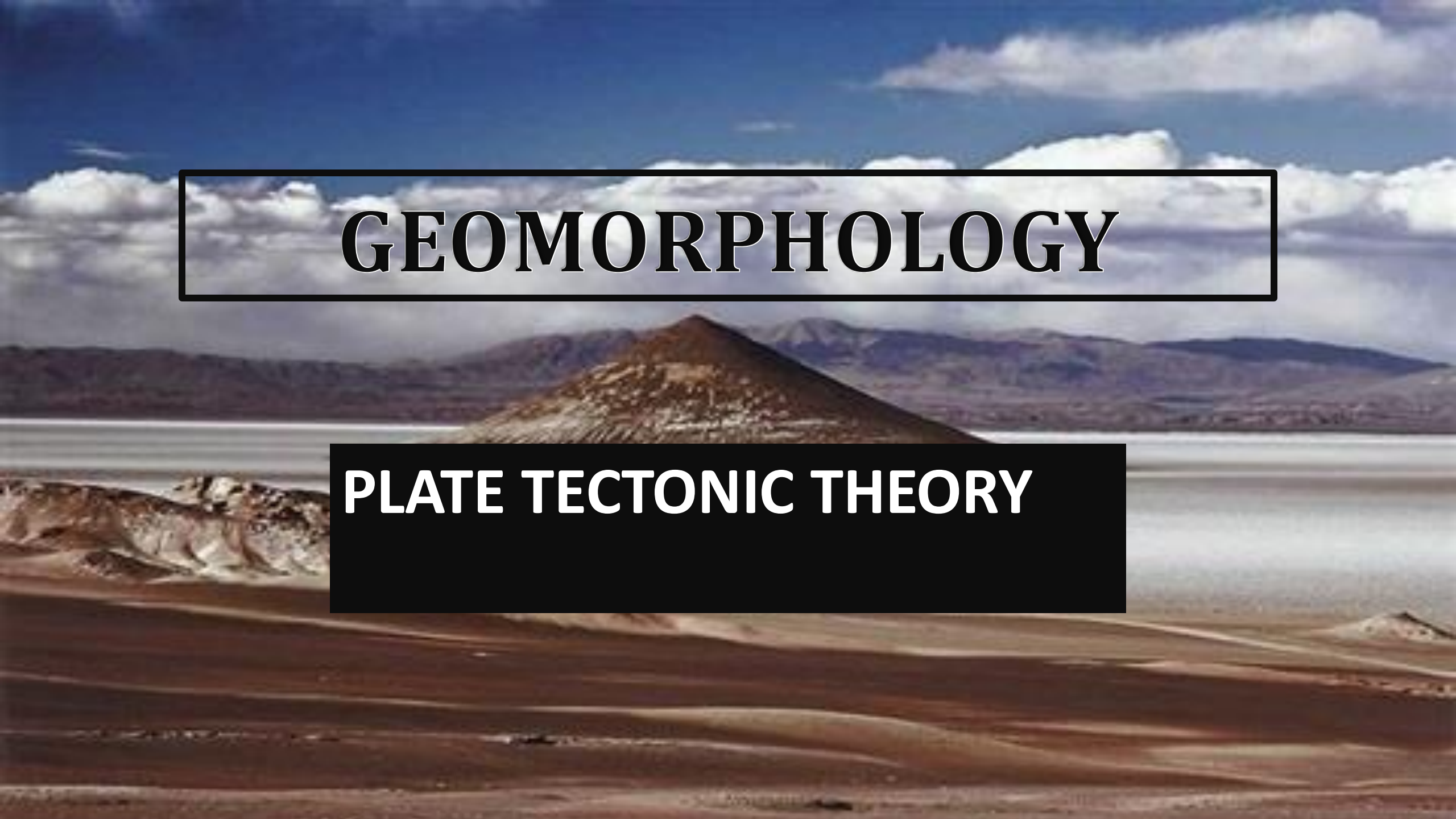
Expected Question

Consider the following statements with regarding the Continental Drift Theory:

- I. Panthalasa was the only ocean that surrounds Pangea.
- II. Gondwanaland was the Southern part of Pangea.
- III. Tethys sea was the dividing factor between Laurasia and Gondwanaland.

Which of the following statements are NOT true:

- a. II and III
- b. I and III
- c. All of the above
- d. None of the above.



GEOMORPHOLOGY

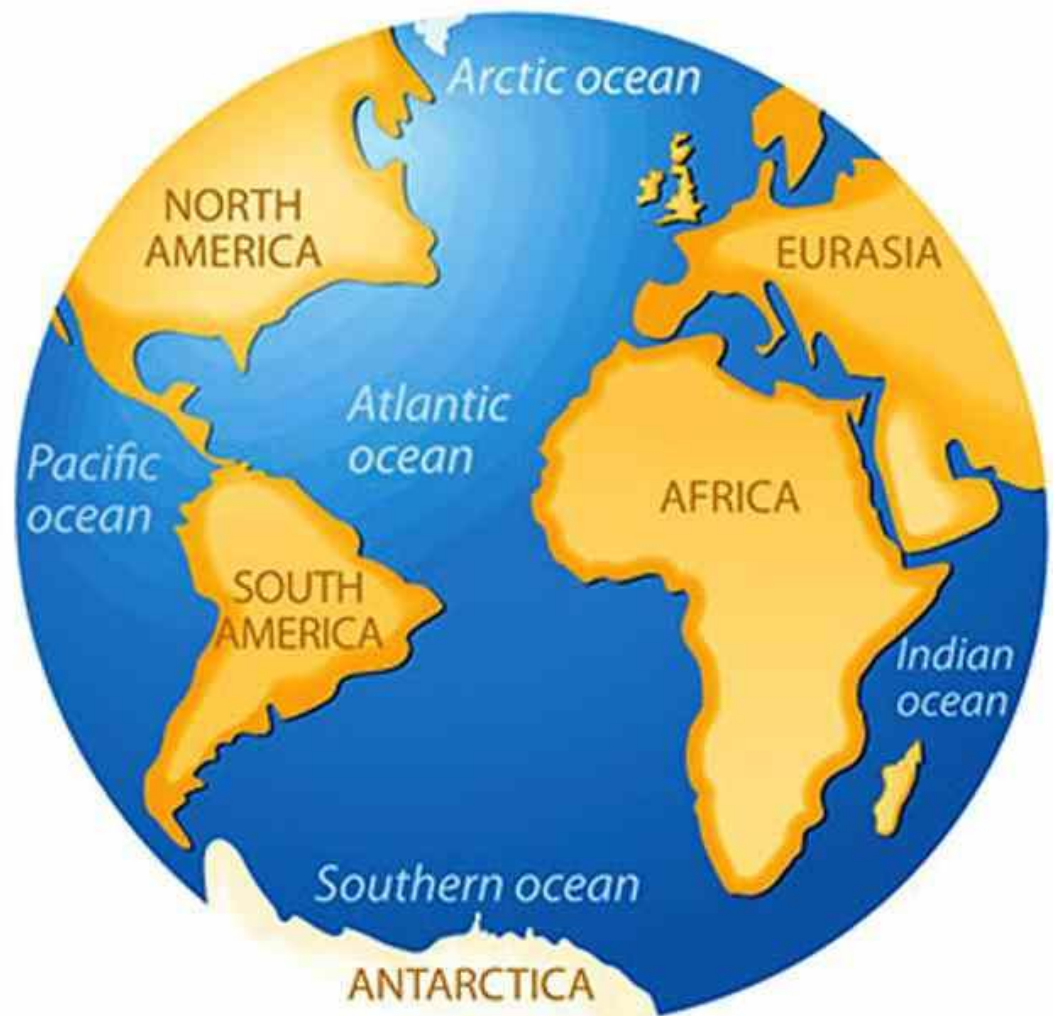
PLATE TECTONIC THEORY

PLATE TECTONICS

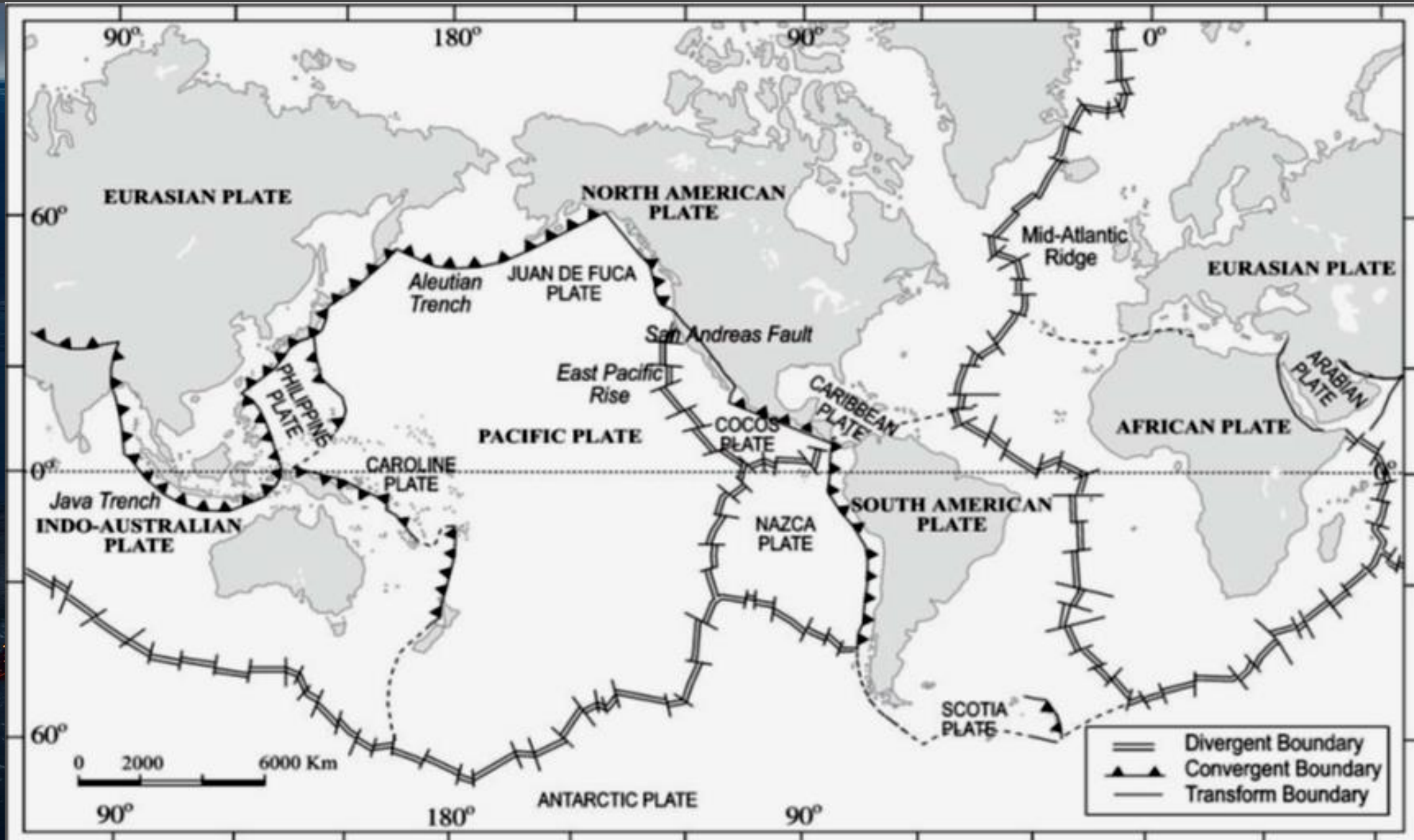
BEFORE

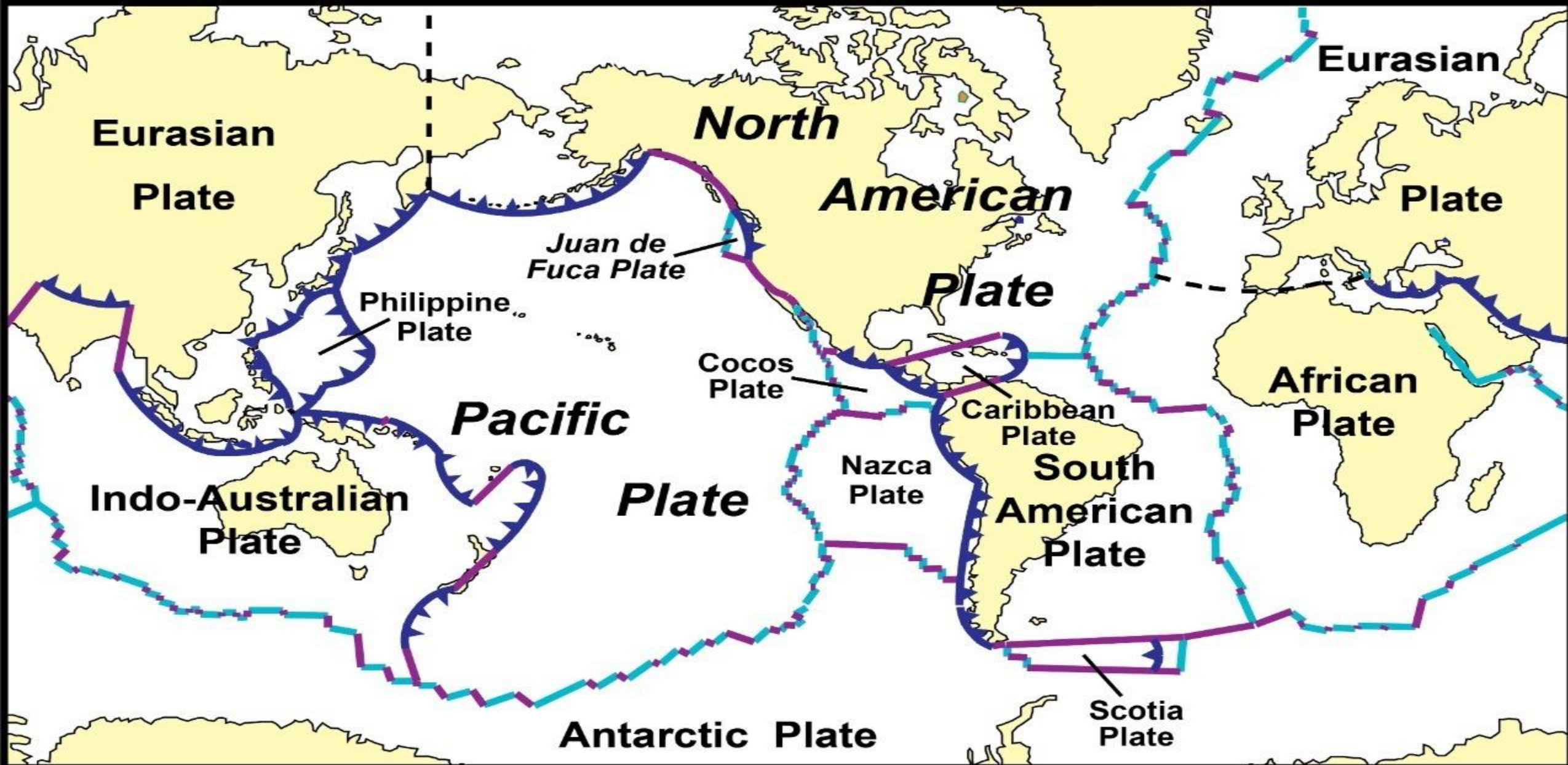


AFTER



MAJOR AND MINOR PLATES





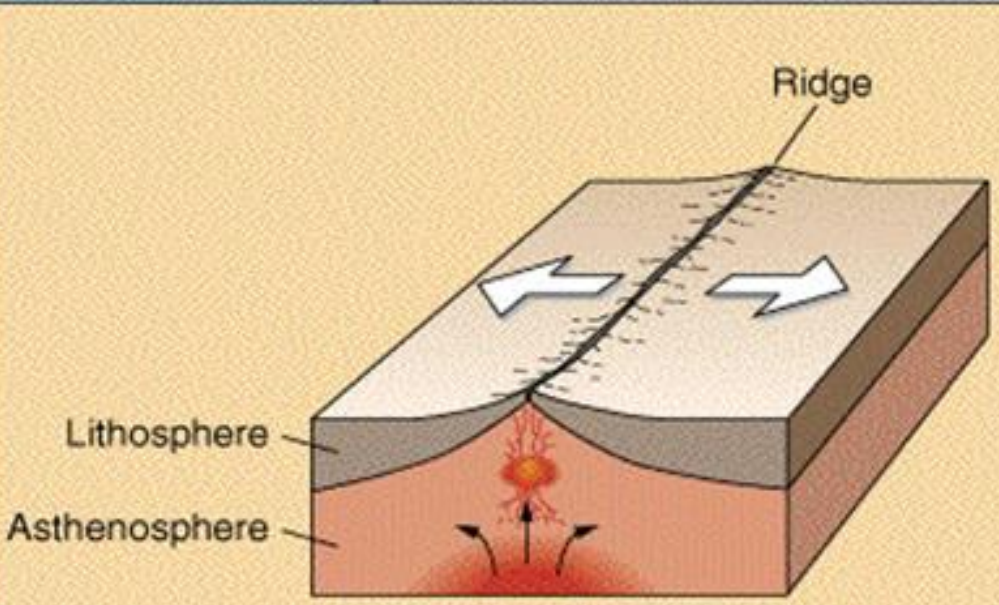
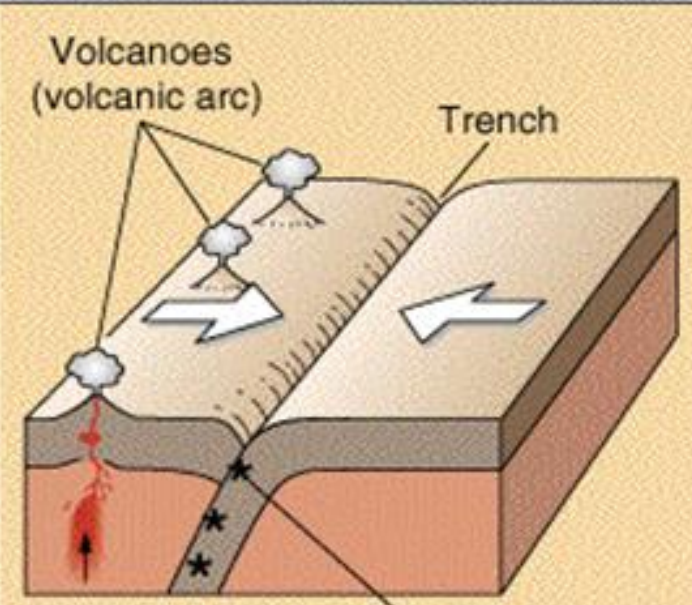
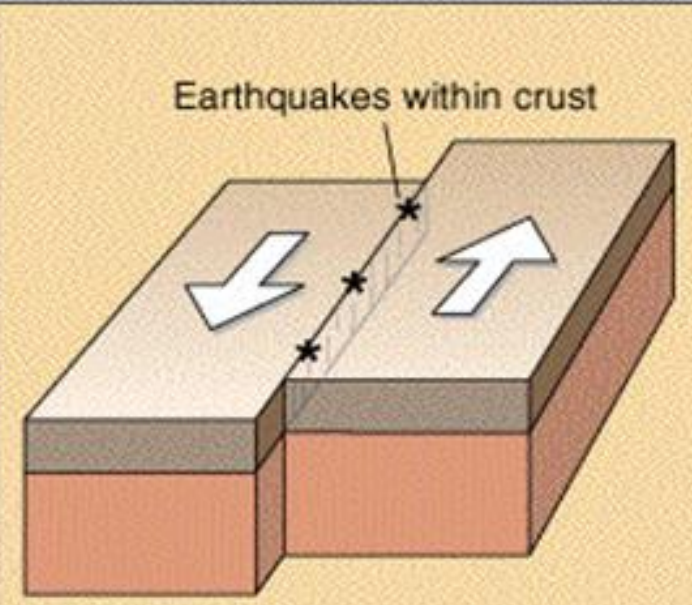
Divergent
Plate
Boundary

Convergent
Plate
Boundary

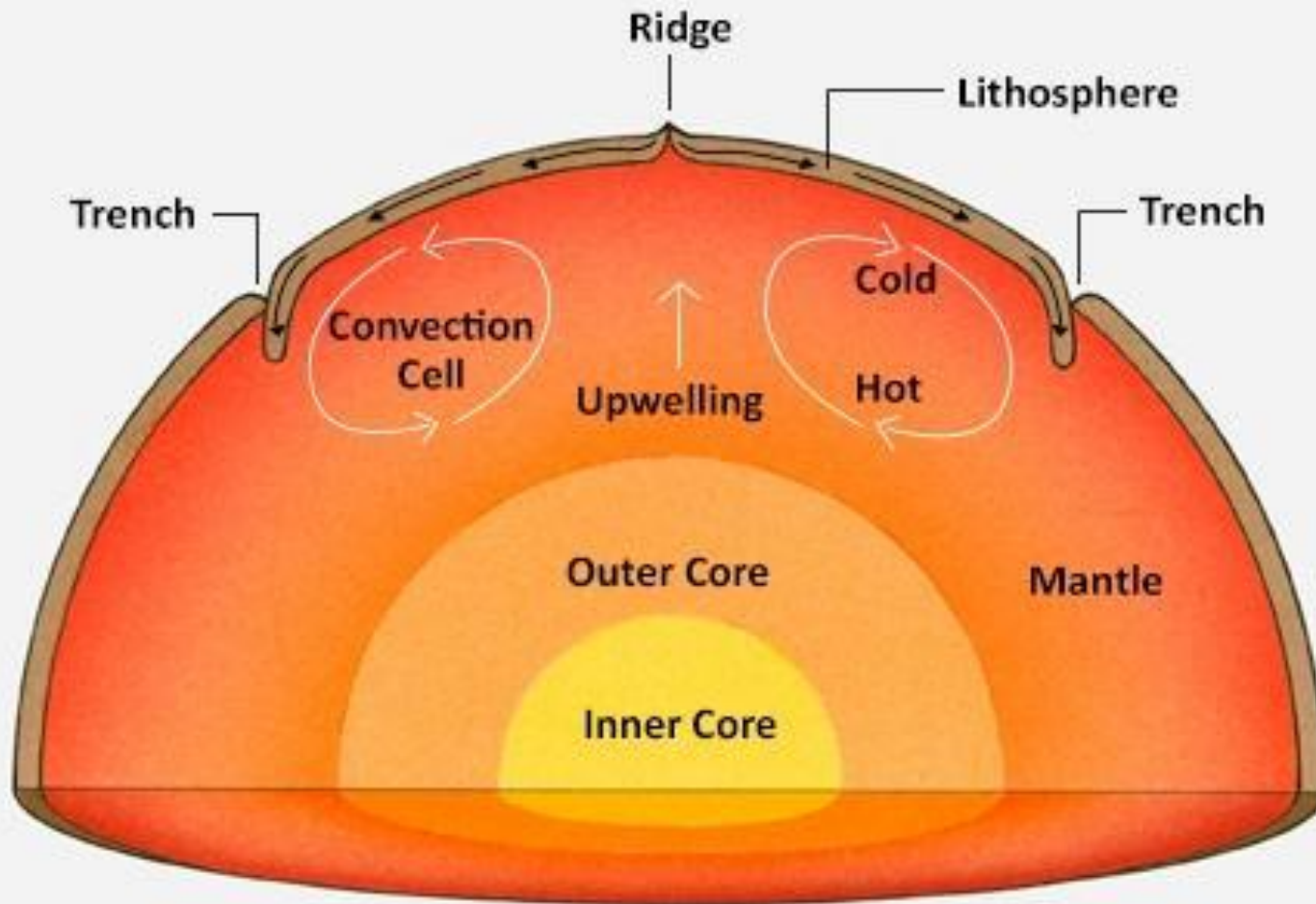
Transform
Plate
Boundary

PLATE BOUNDARIES

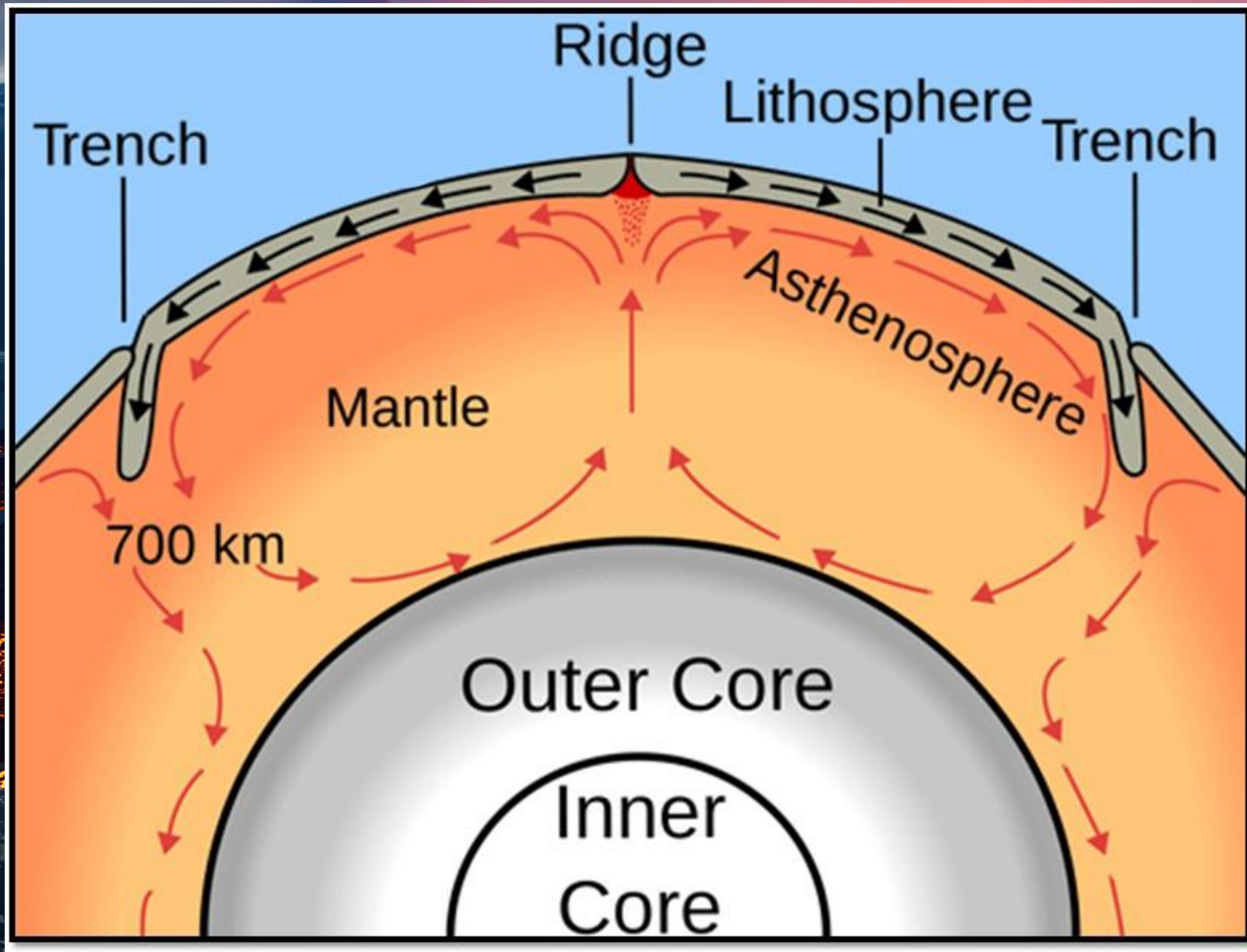
Type of Margin	Divergent	Convergent	Transform
Motion	Spreading	Subduction	Lateral sliding
Effect	Constructive (oceanic lithosphere created)	Destructive (oceanic lithosphere destroyed)	Conservative (lithosphere neither created or destroyed)
Topography	Ridge/Rift	Trench	No major effect
Volcanic activity?	Yes	Yes	No

 (a)	 (b)	 (c)
---	---	---

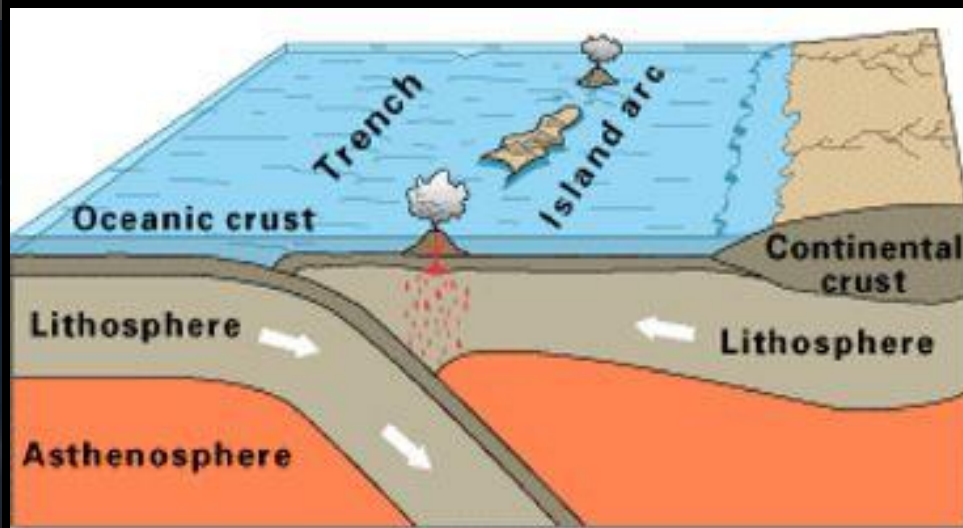
THERMAL CONVECTION



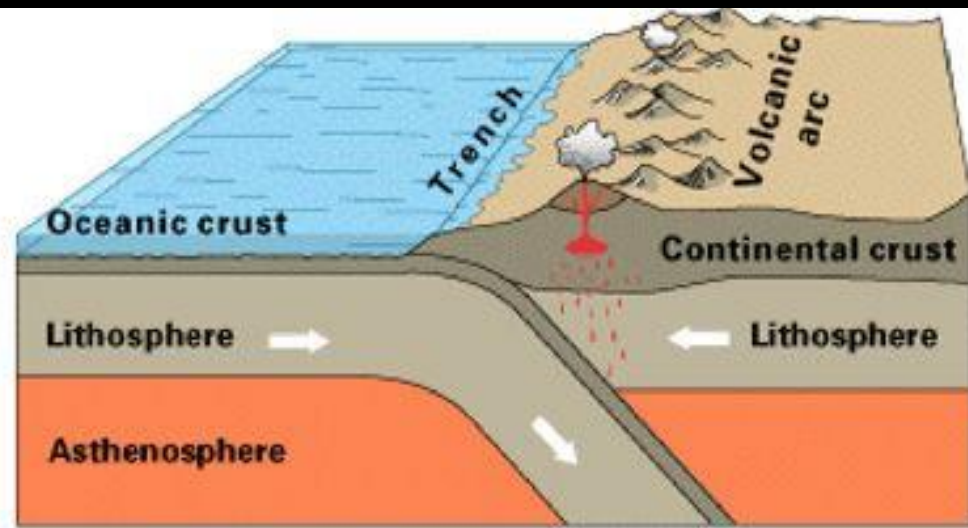
RIDGES AND TRENCHES



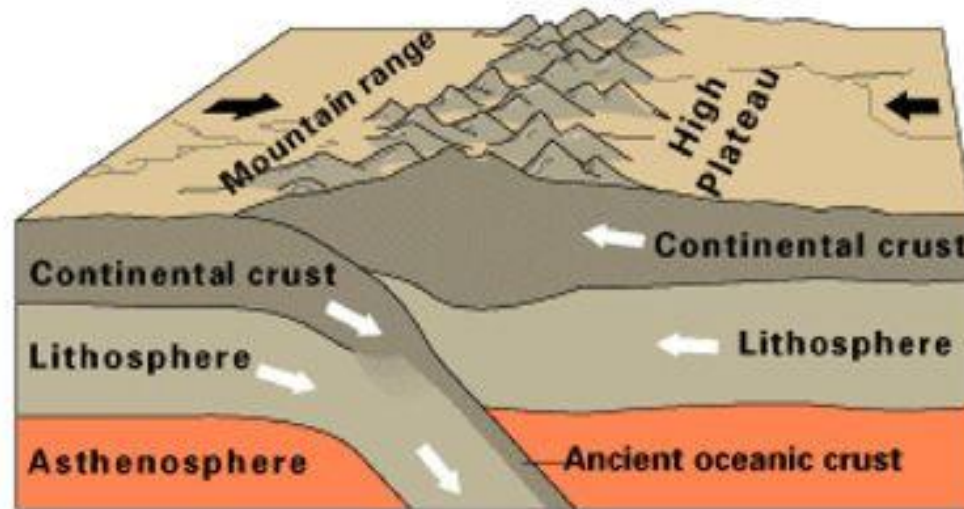
CONVERGENT BOUNDARY



Oceanic-oceanic convergence

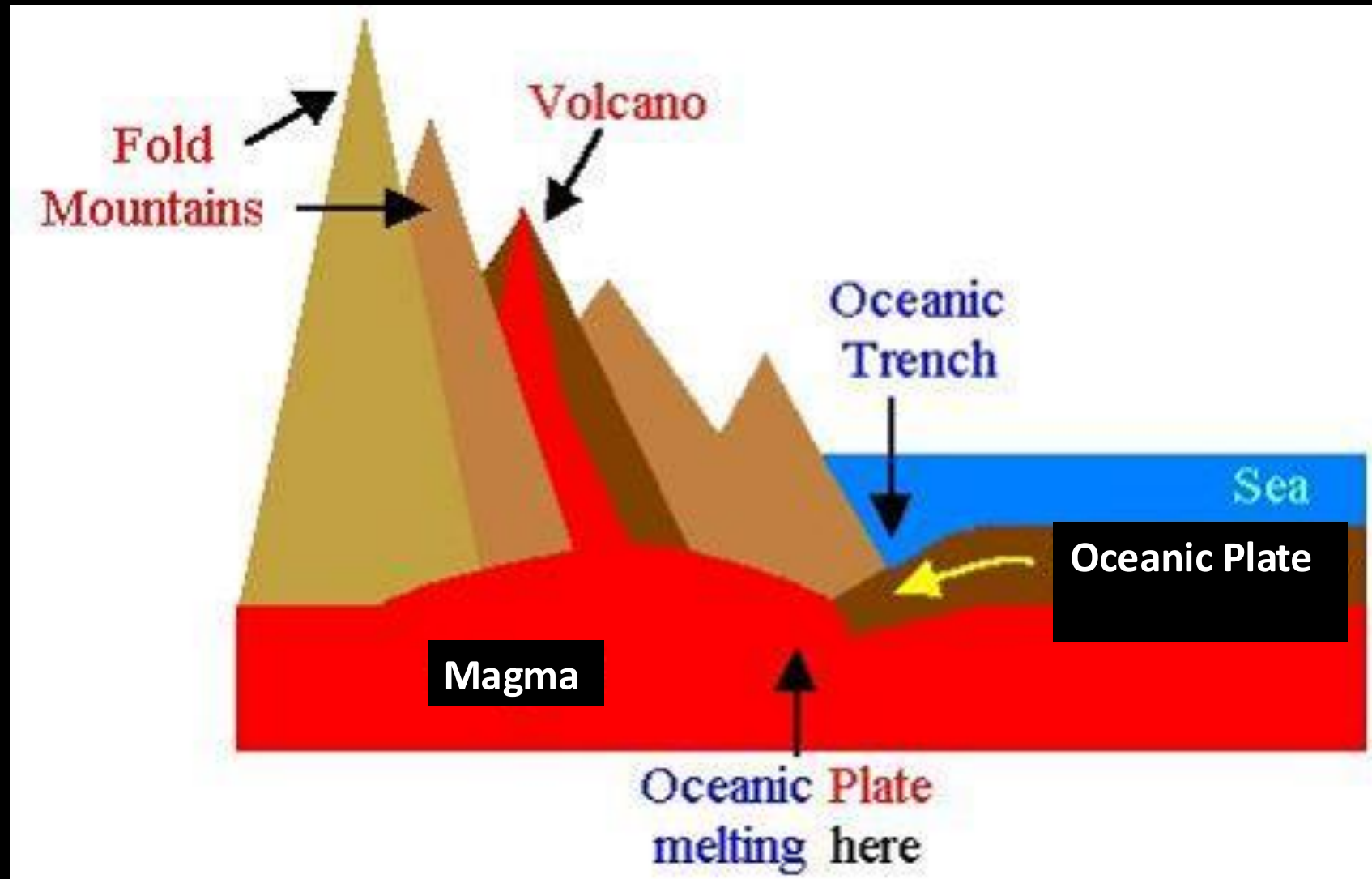


Oceanic-continental convergence

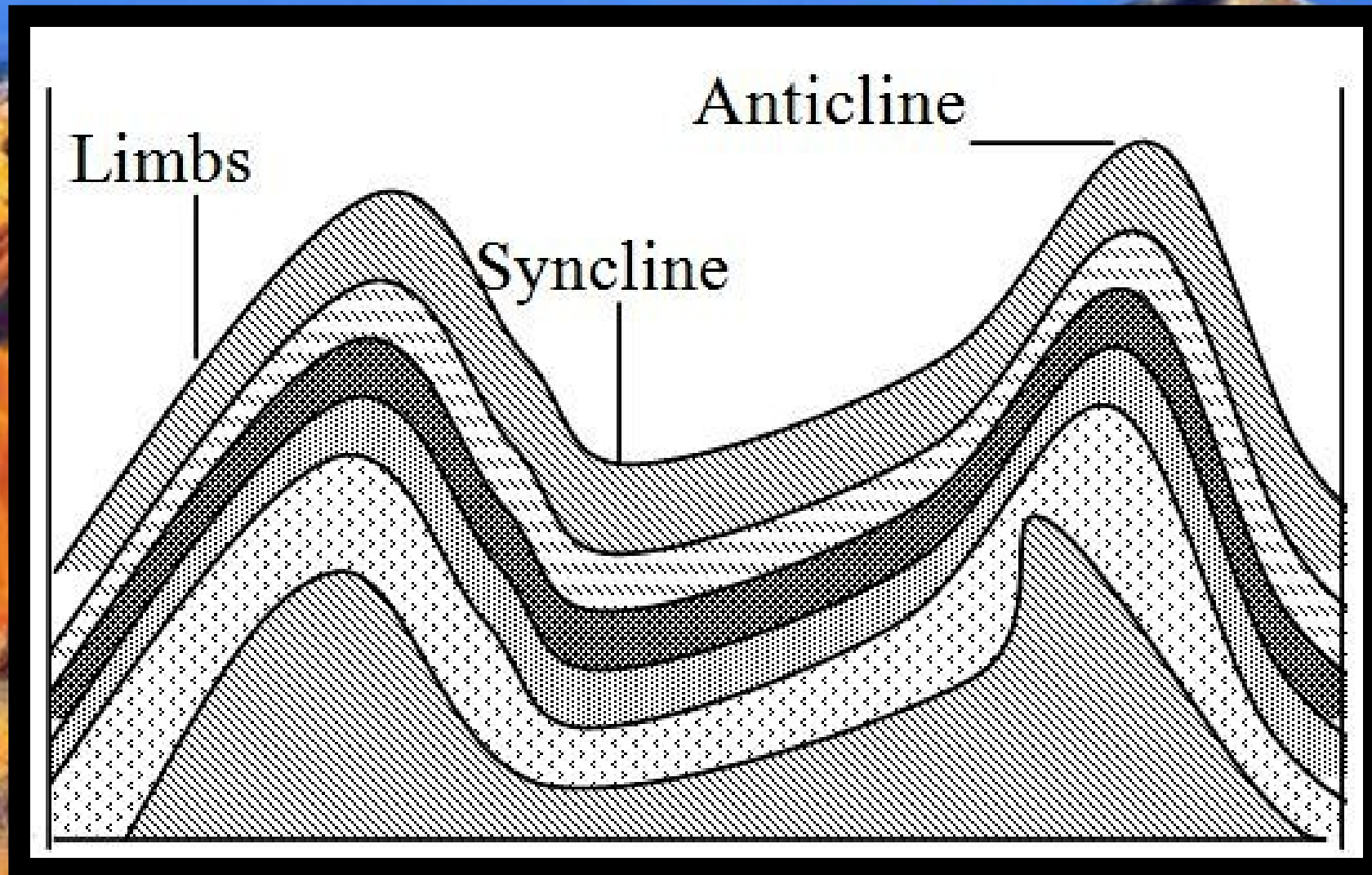


Continental-continental convergence

FOLD MOUNTAINS

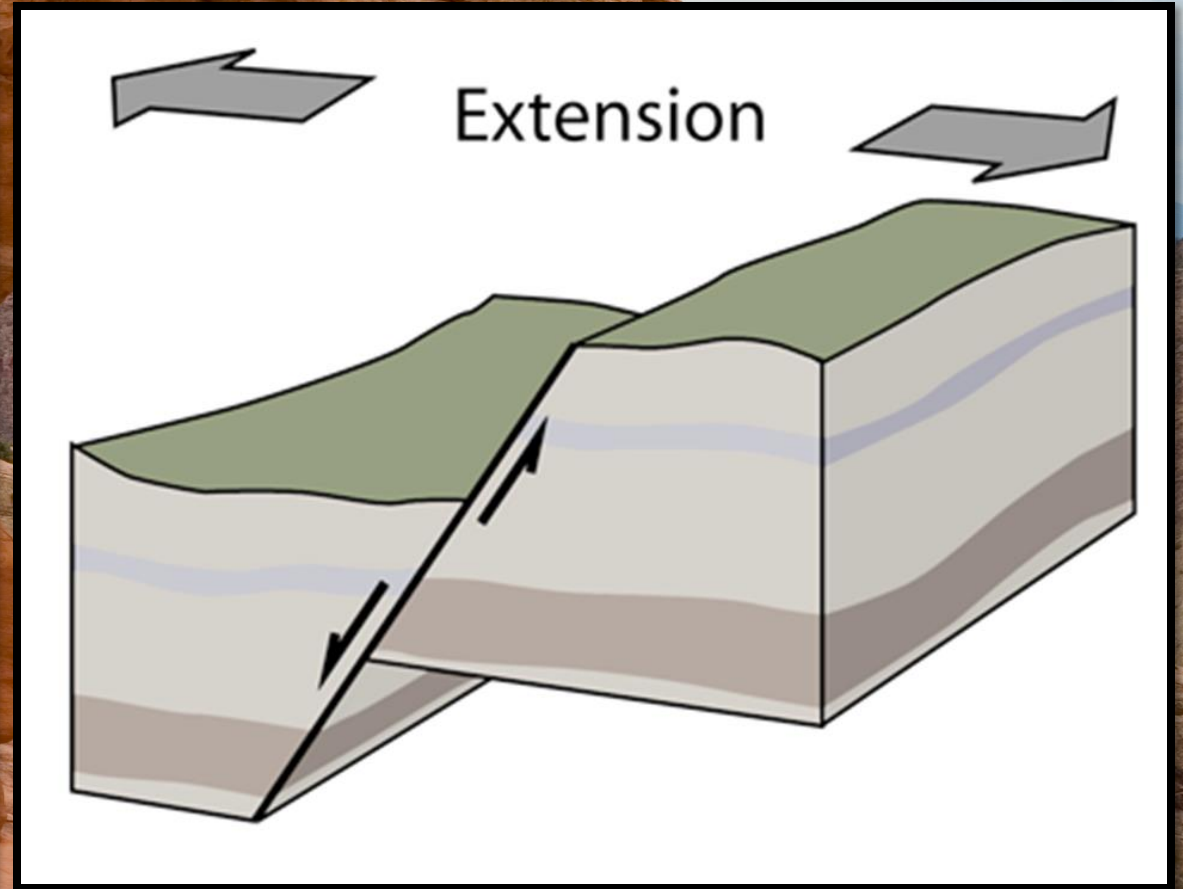
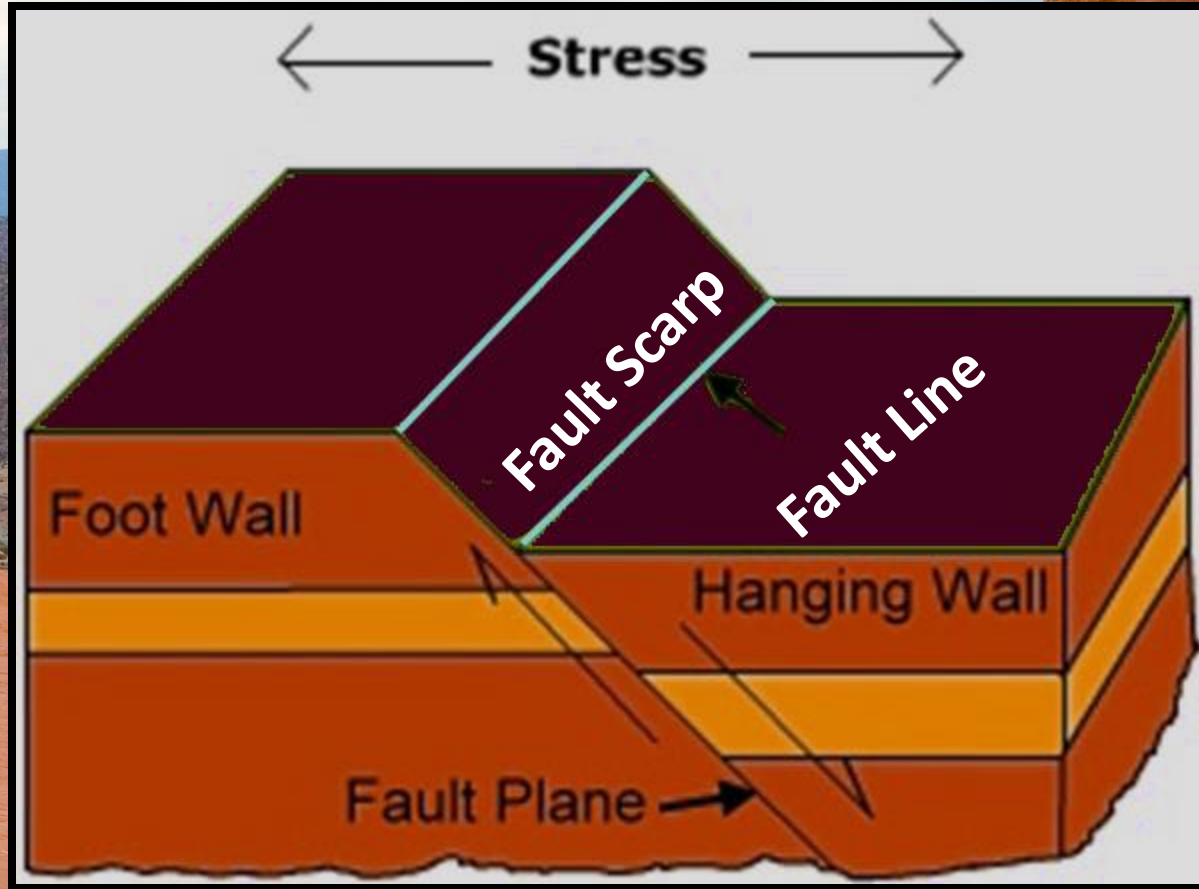


FOLDING

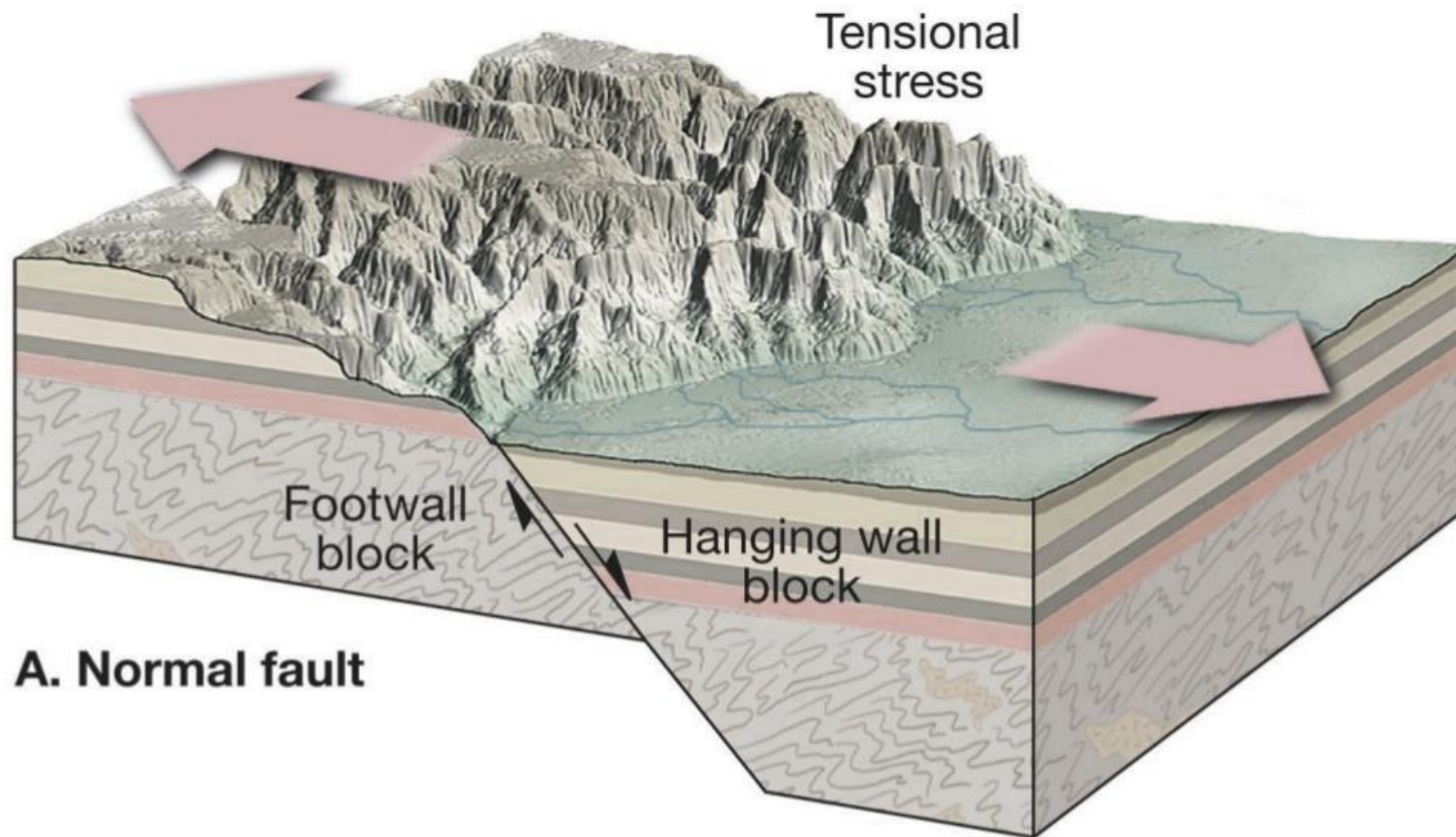




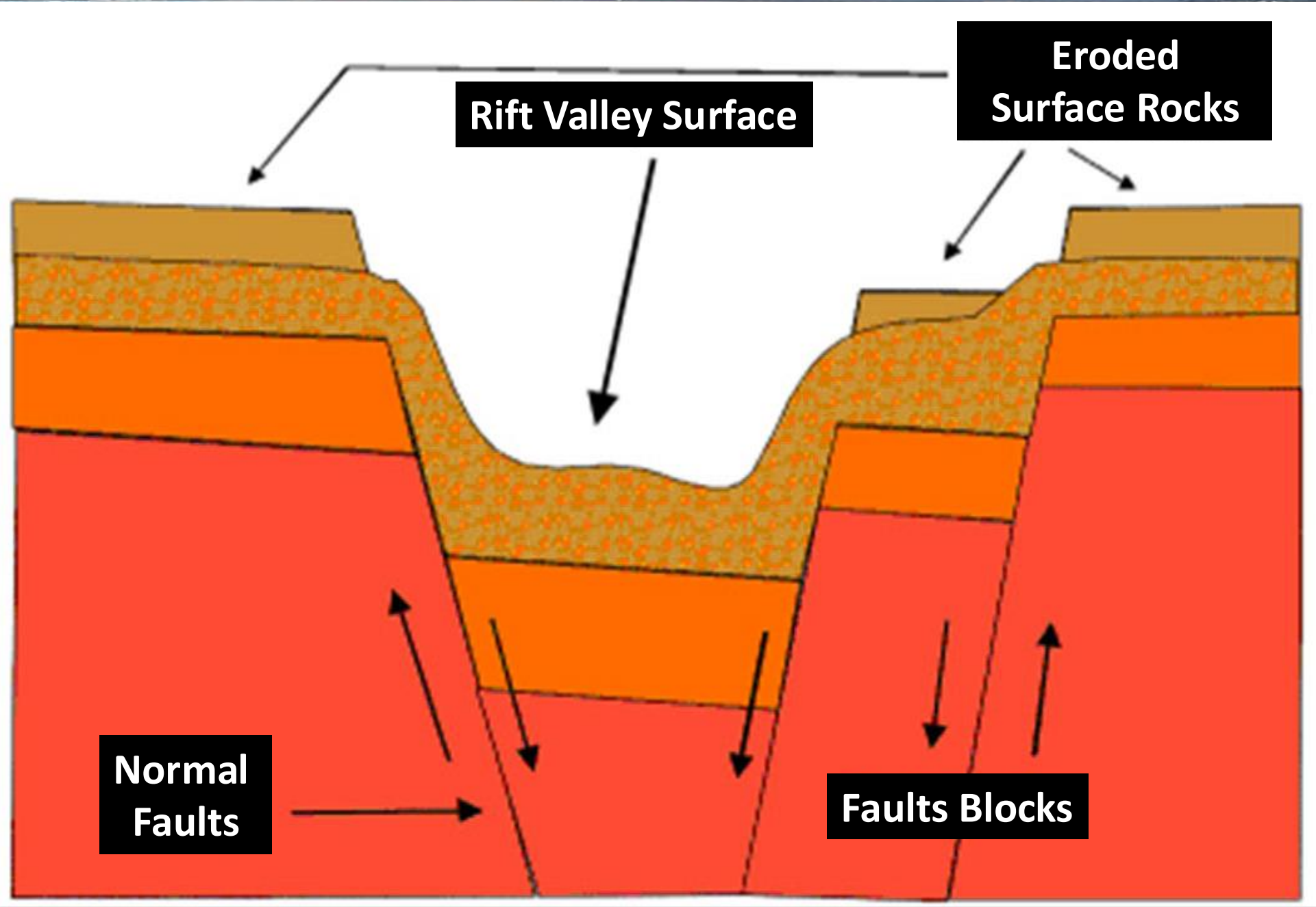
FAULTING

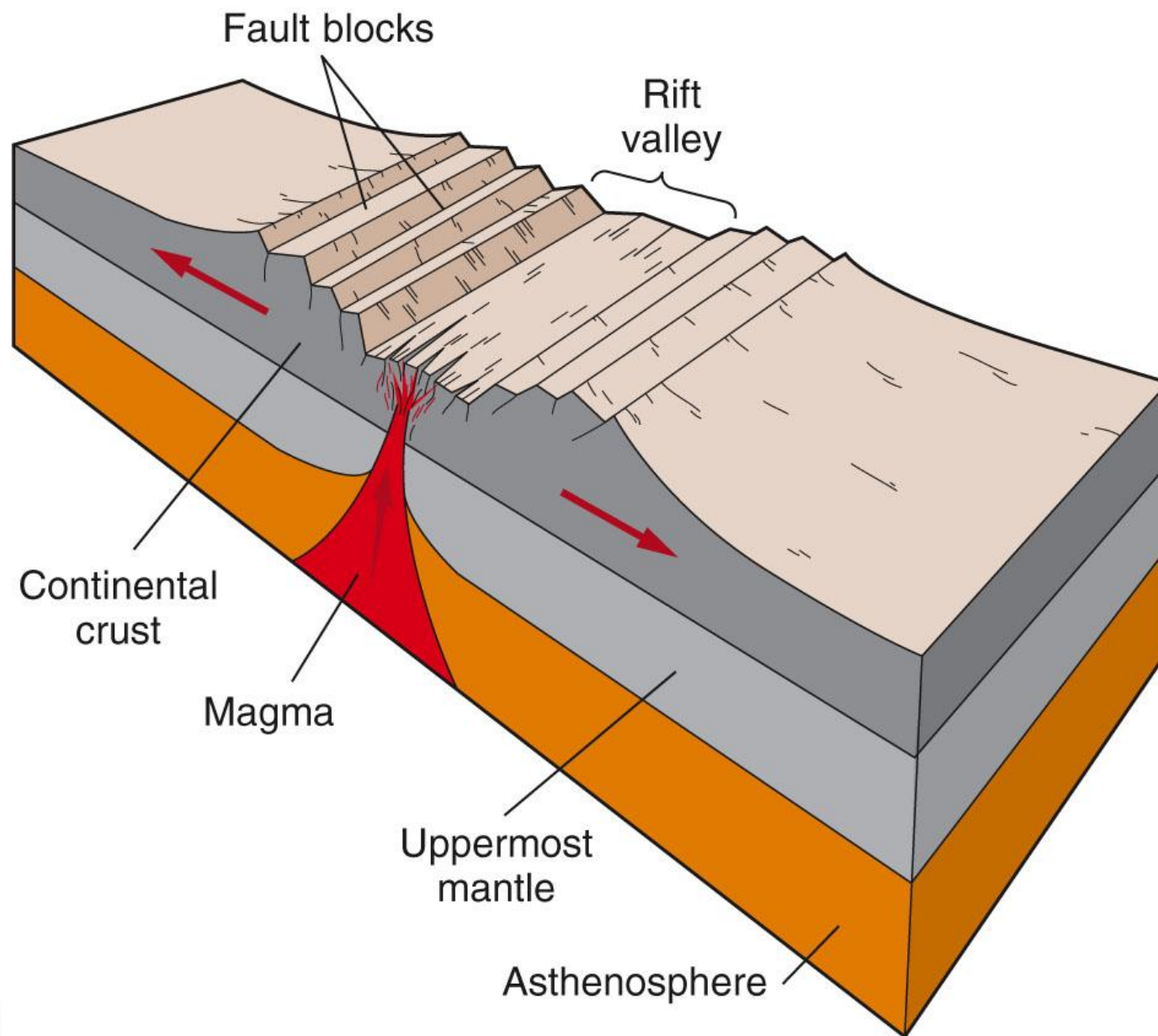


A normal fault

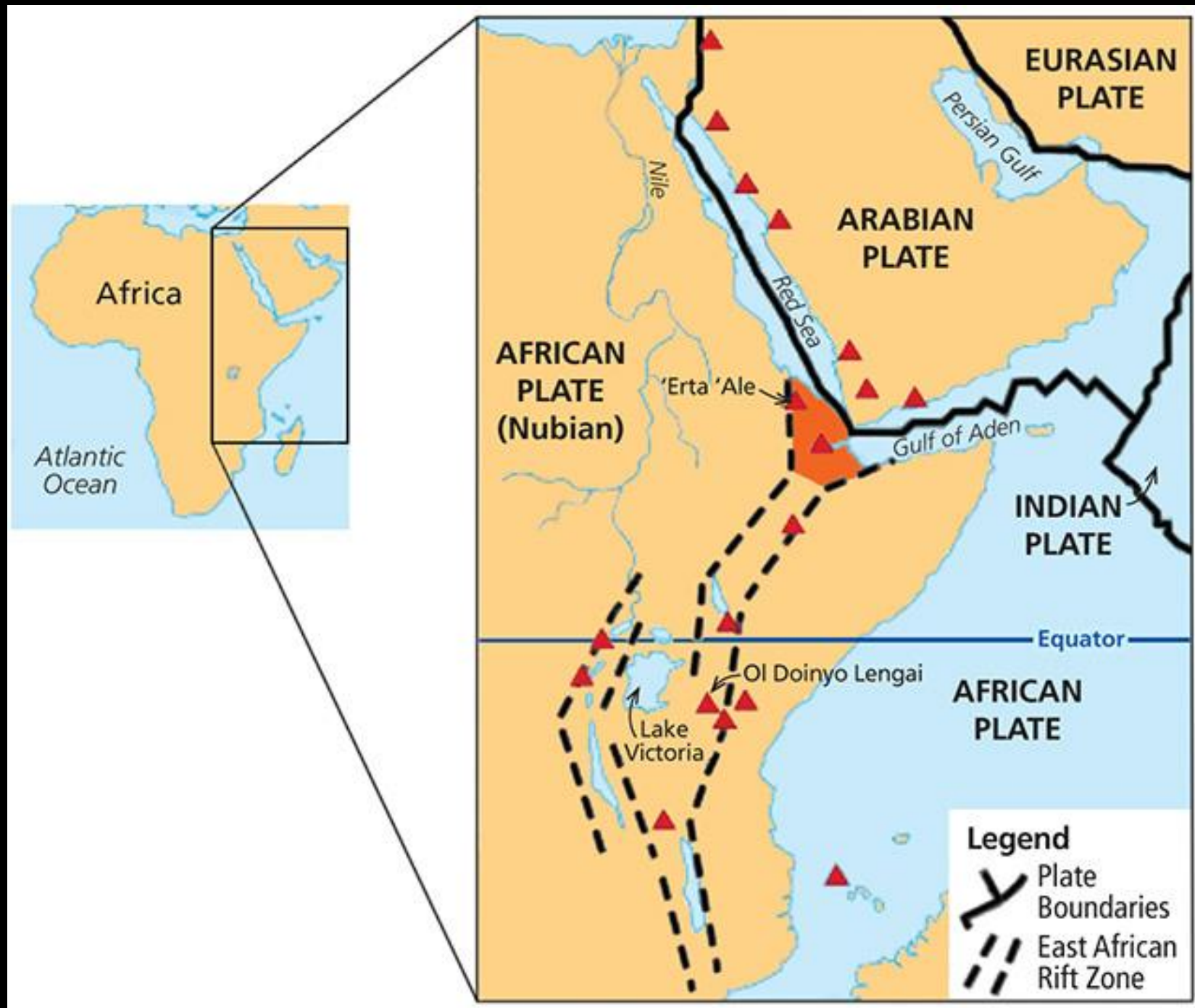


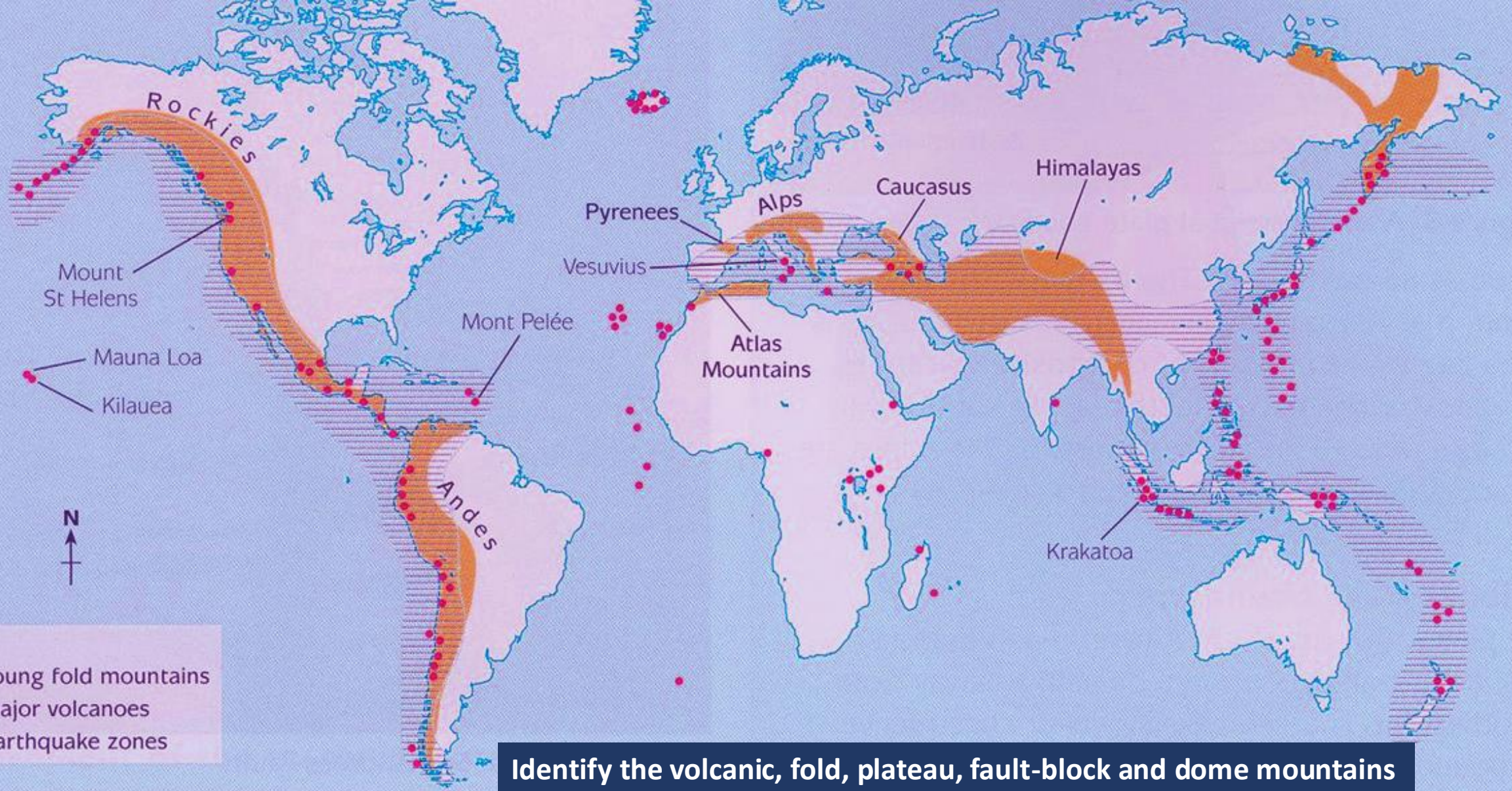
A. Normal fault





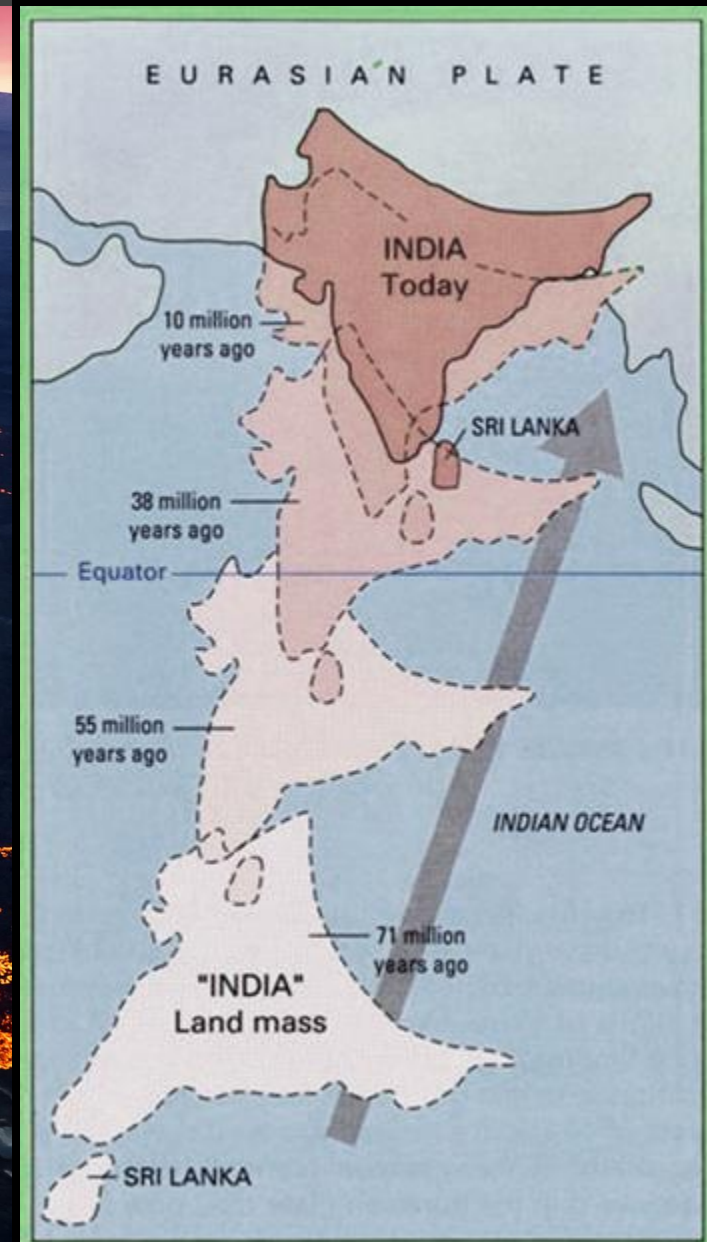
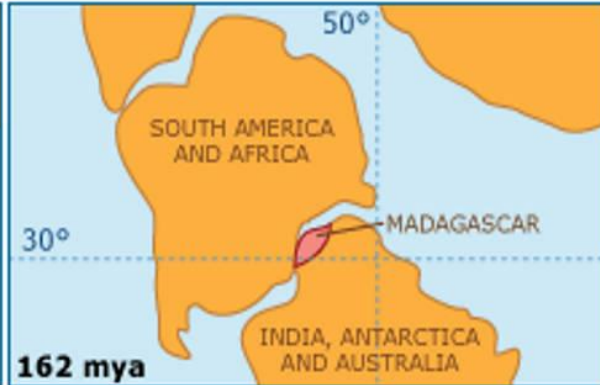
(a)

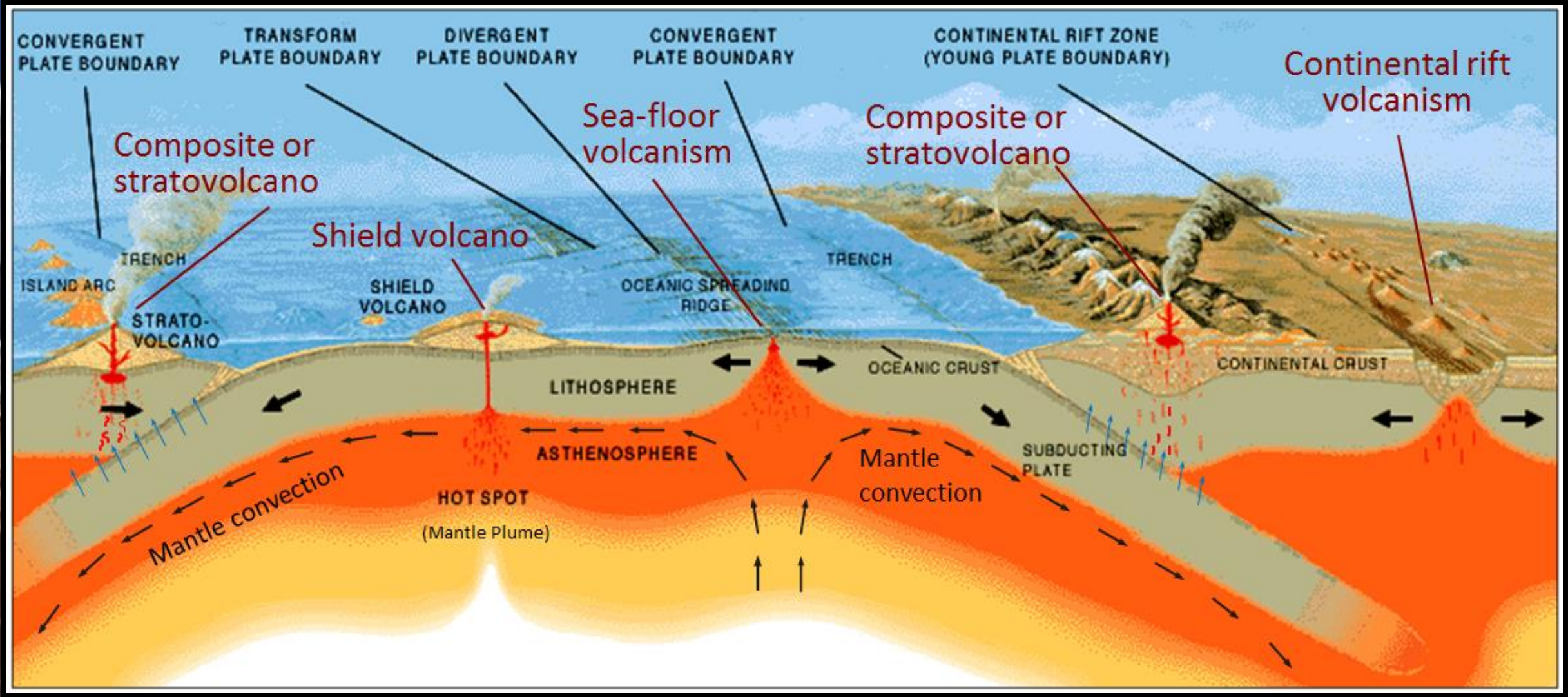




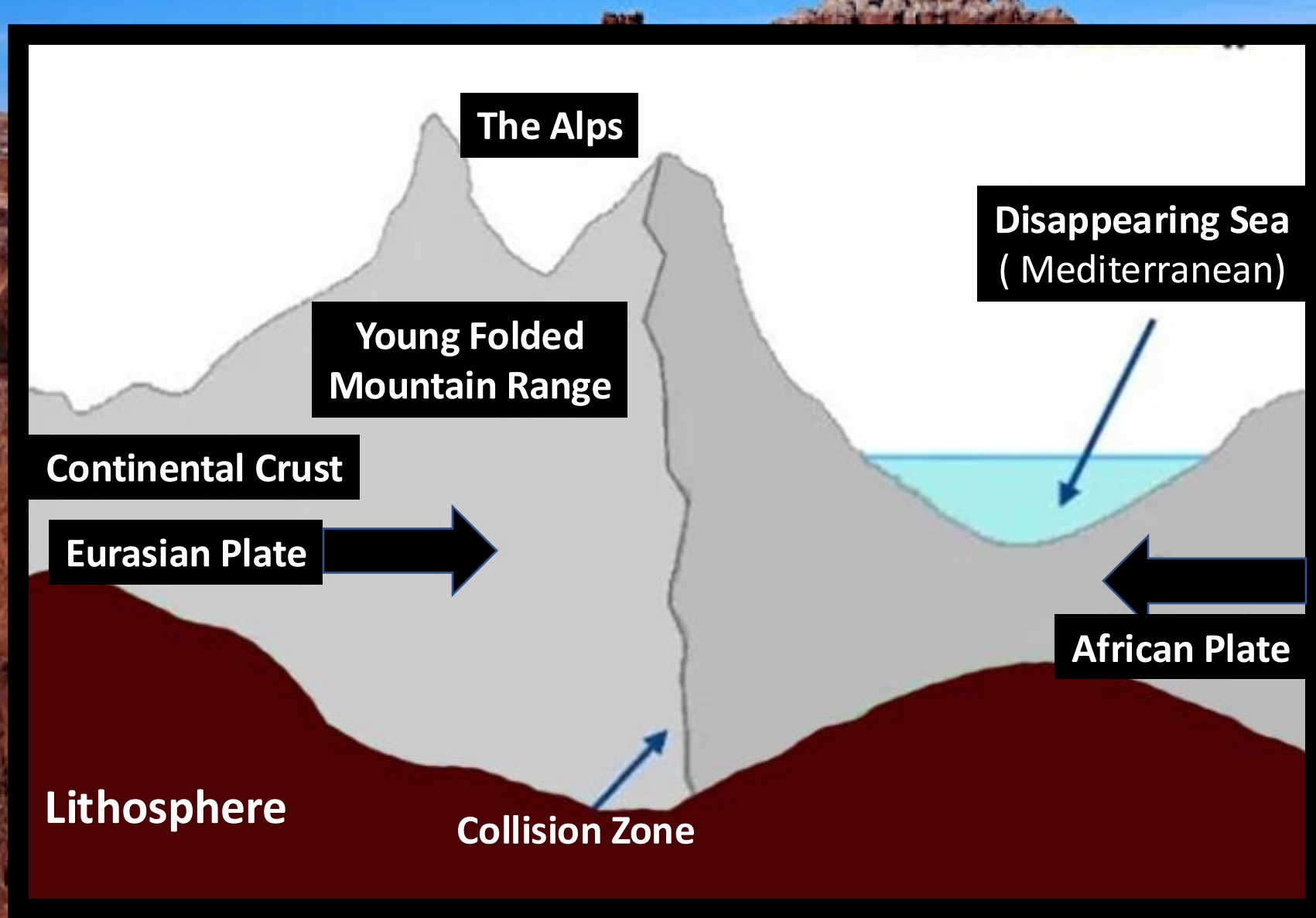
The world distribution of young fold mountains, active volcanoes and earthquake zones.

INDIAN PLATE MOVEMENT

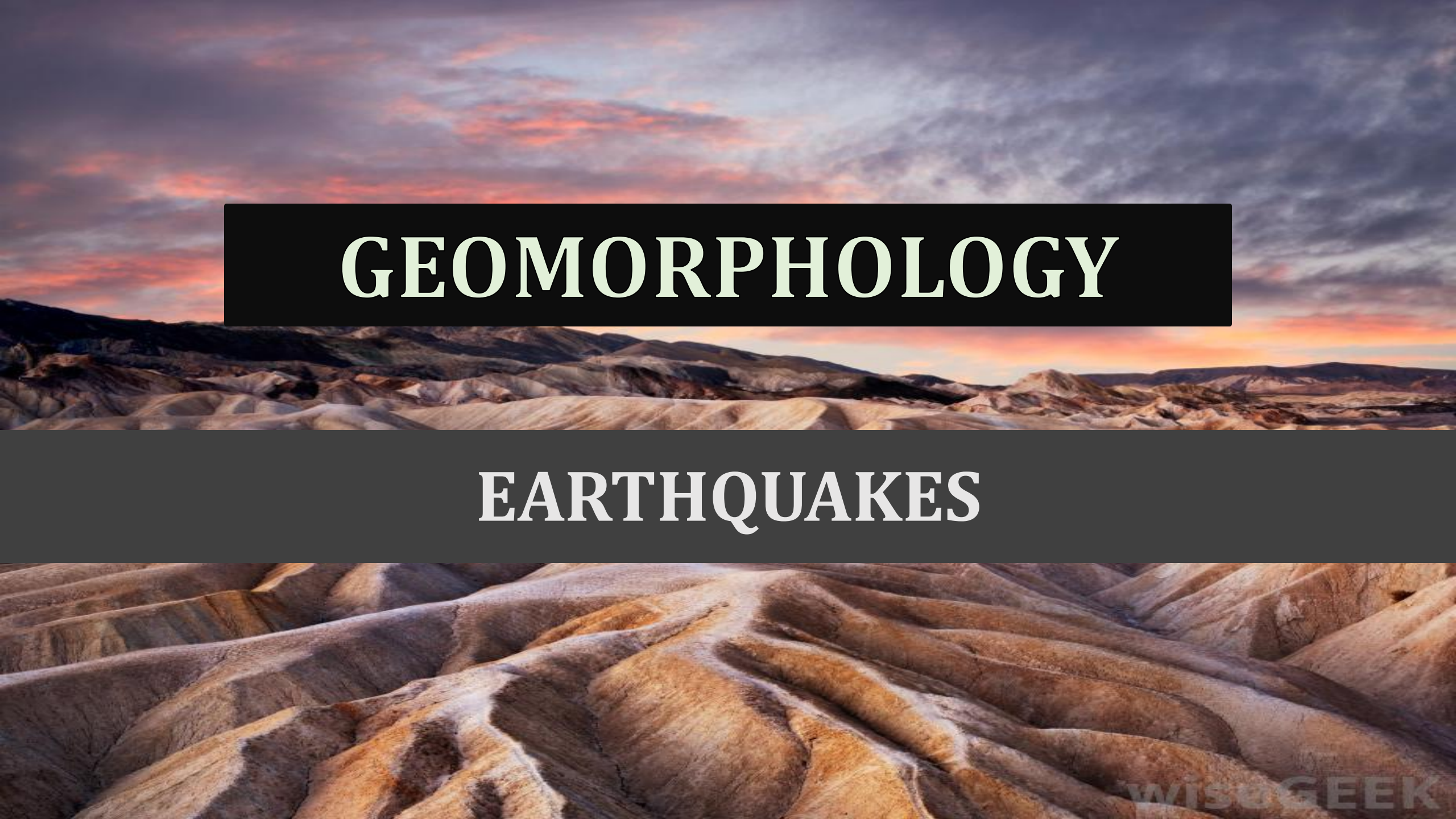




DISAPPEARING SEA



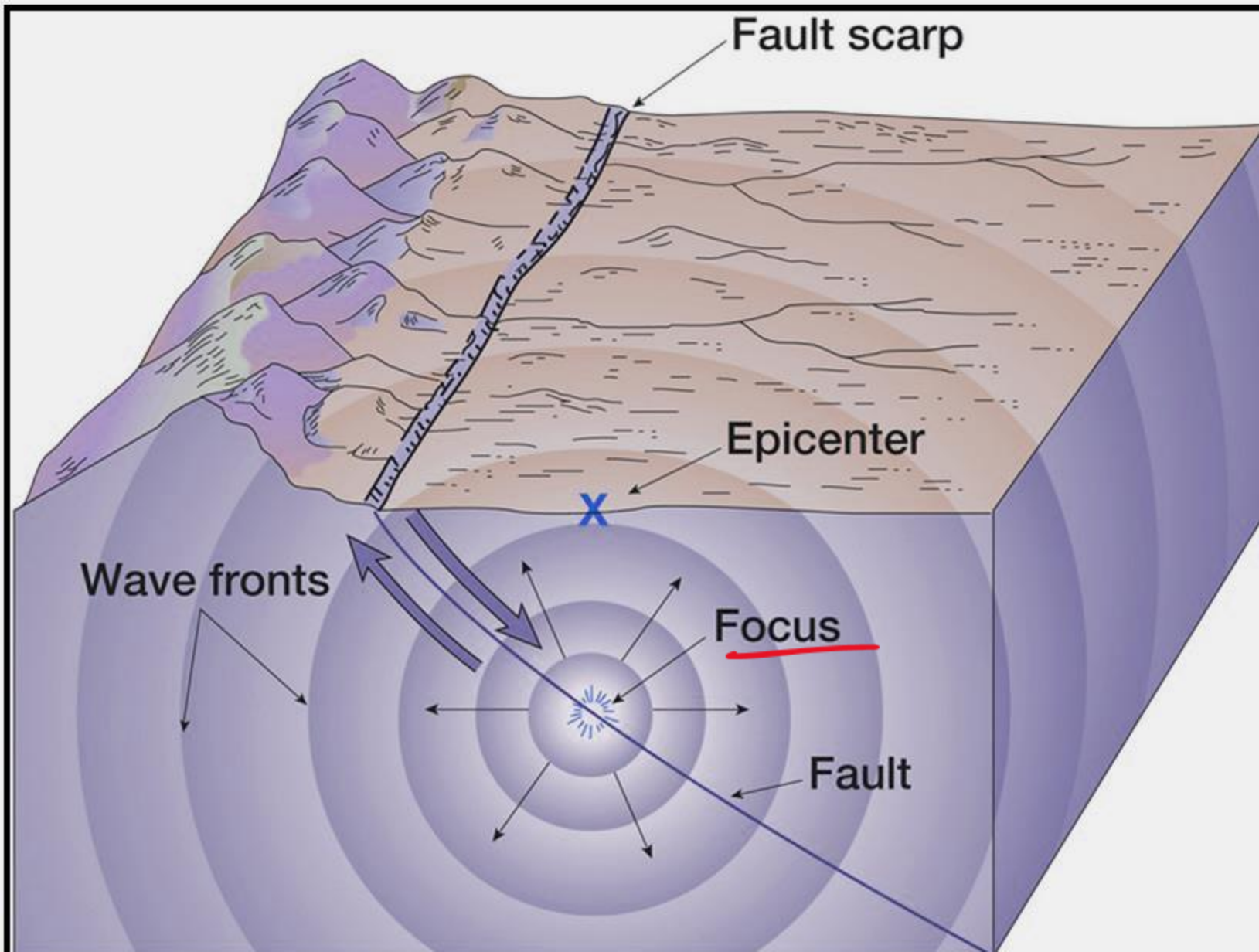




GEOMORPHOLOGY

EARTHQUAKES

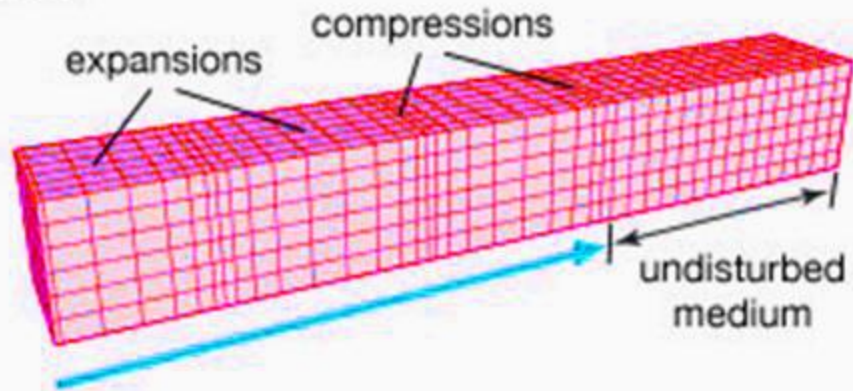
FOCUS AND EPICENTRE



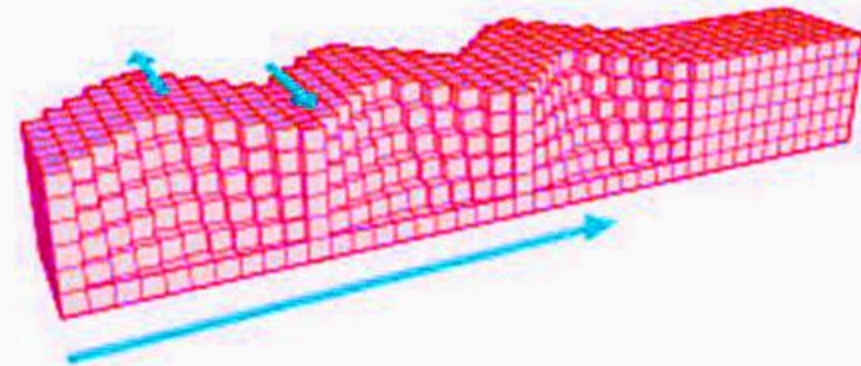
EARTHQUAKE WAVES

Main types of seismic waves

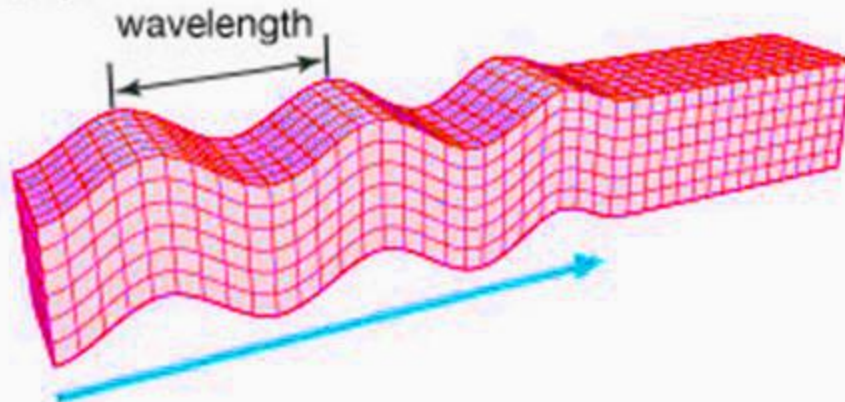
P wave



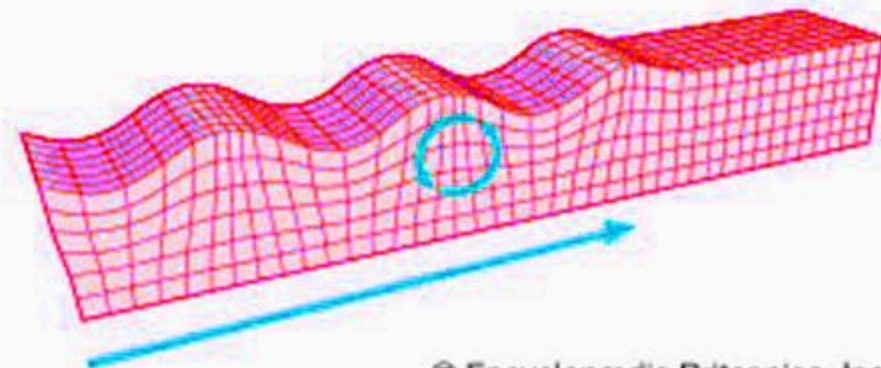
Love wave



S wave



Rayleigh wave



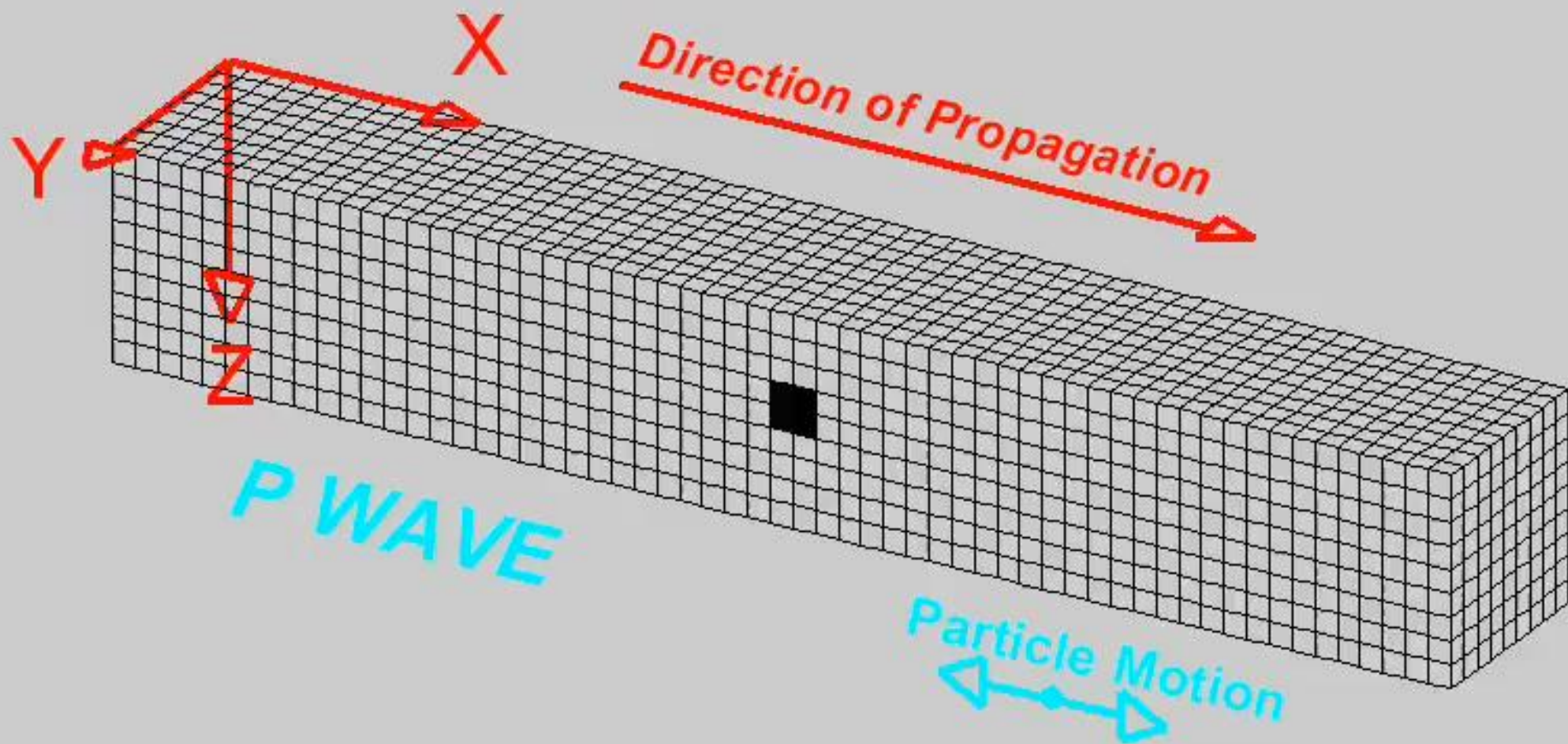
Primary Waves (P-waves)

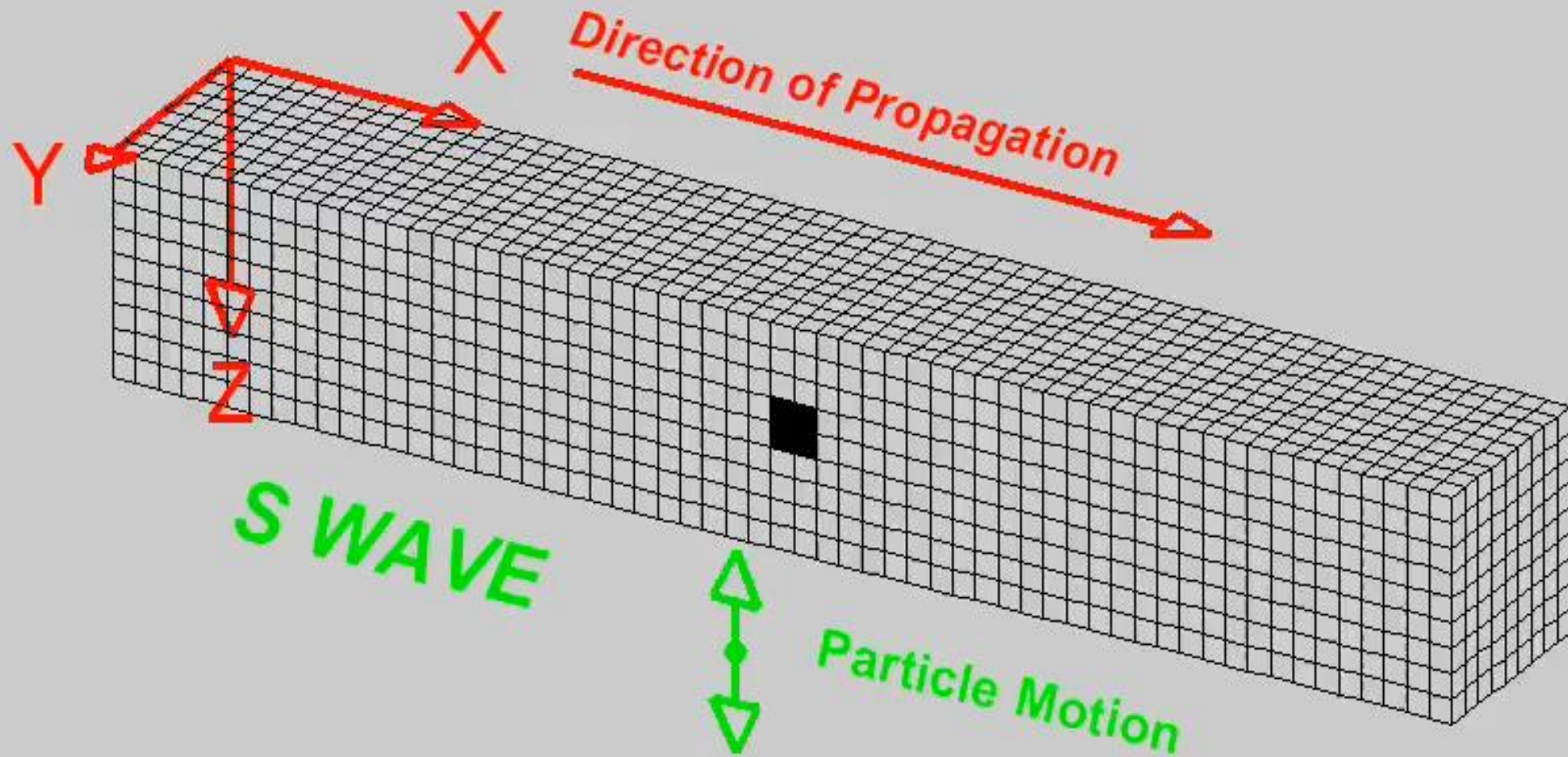
- P-waves are also called as the longitudinal waves, compressional waves, pressure waves.
- P-waves creates density differences in the material leading to stretching (rarefaction) and squeezing (compression) of the material.
- They can travel in all mediums, and their velocity depends on shear strength (elasticity) of the medium.

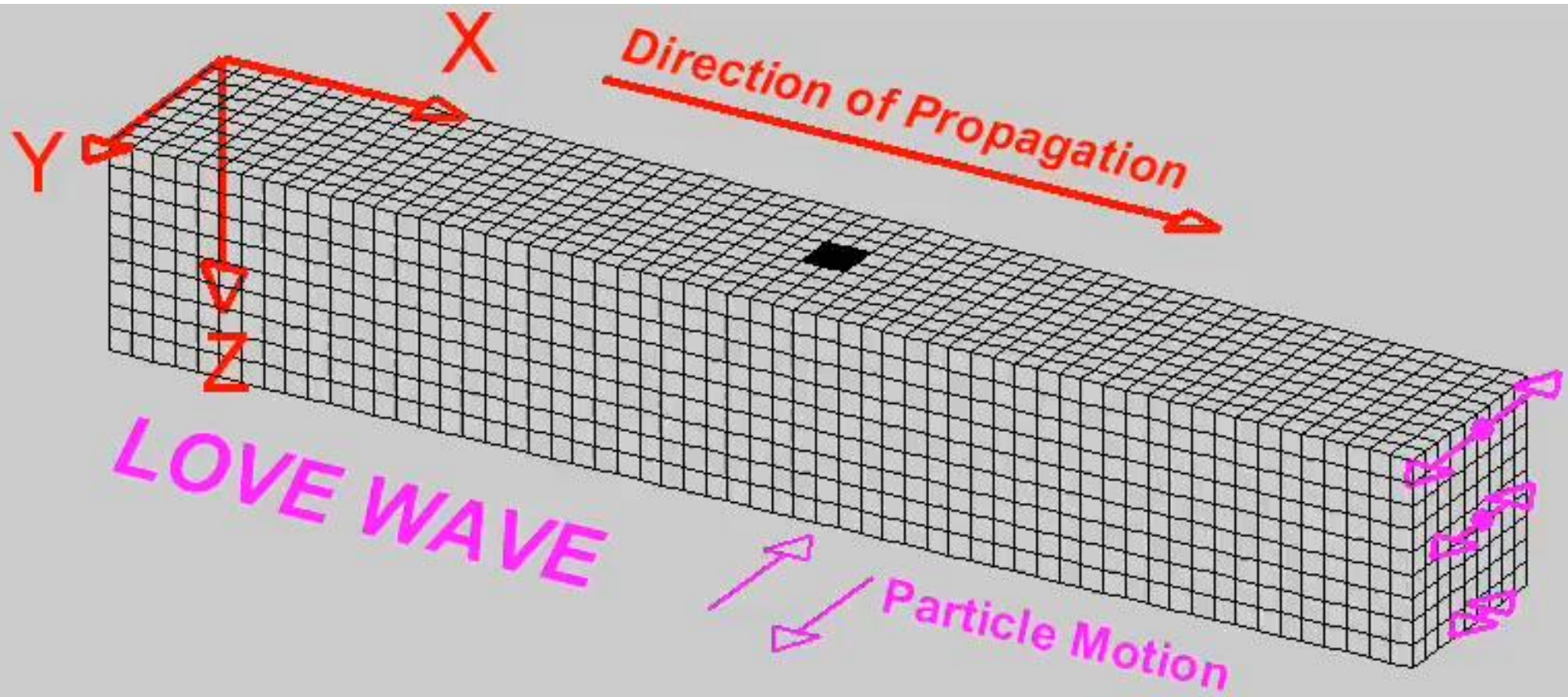
Hence, the velocity of the P-waves in Solids > Liquids > Gases.

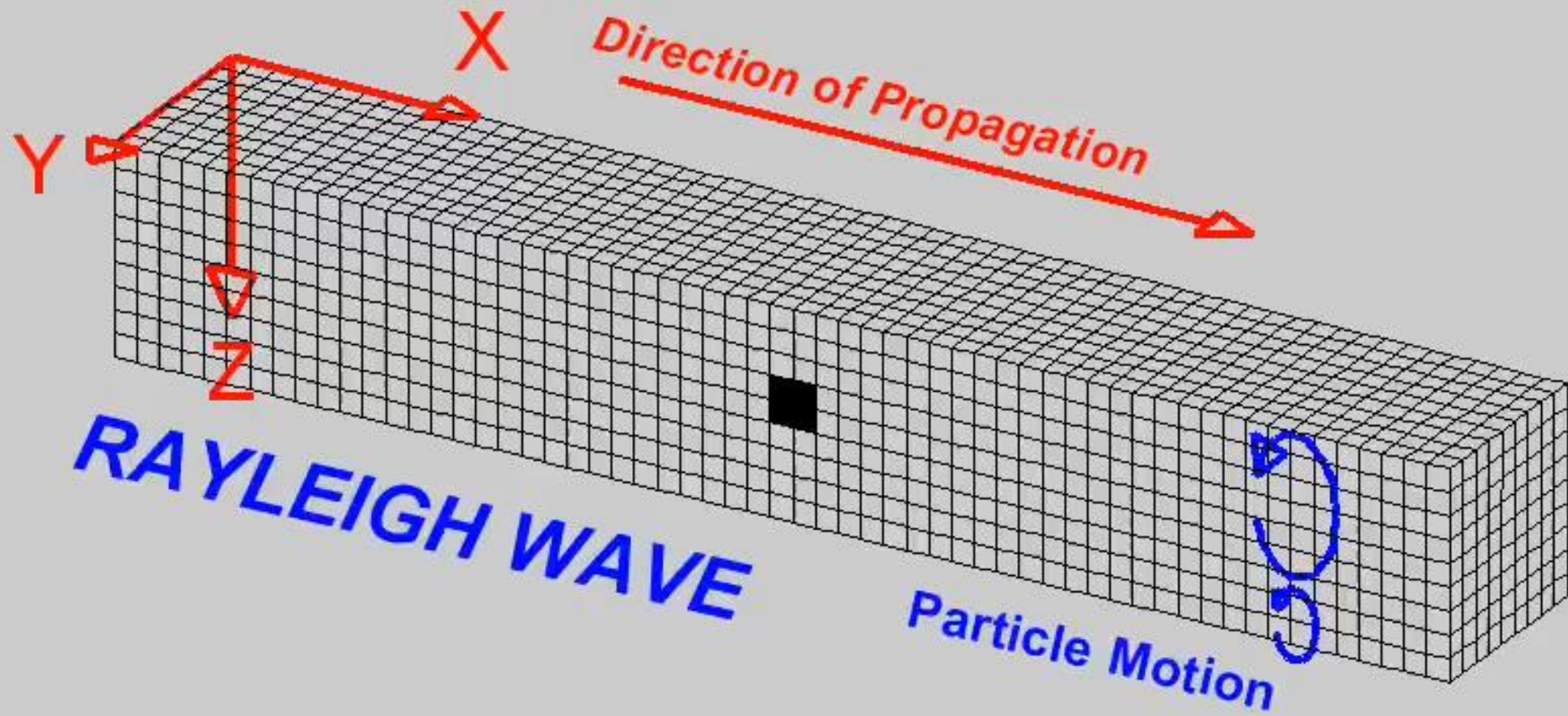
Secondary Waves (S-waves)

- S-waves are also called as transverse waves or shear waves or distortional waves.
- S-waves cannot pass through fluids (liquids and gases) as fluids do not support shear stresses.

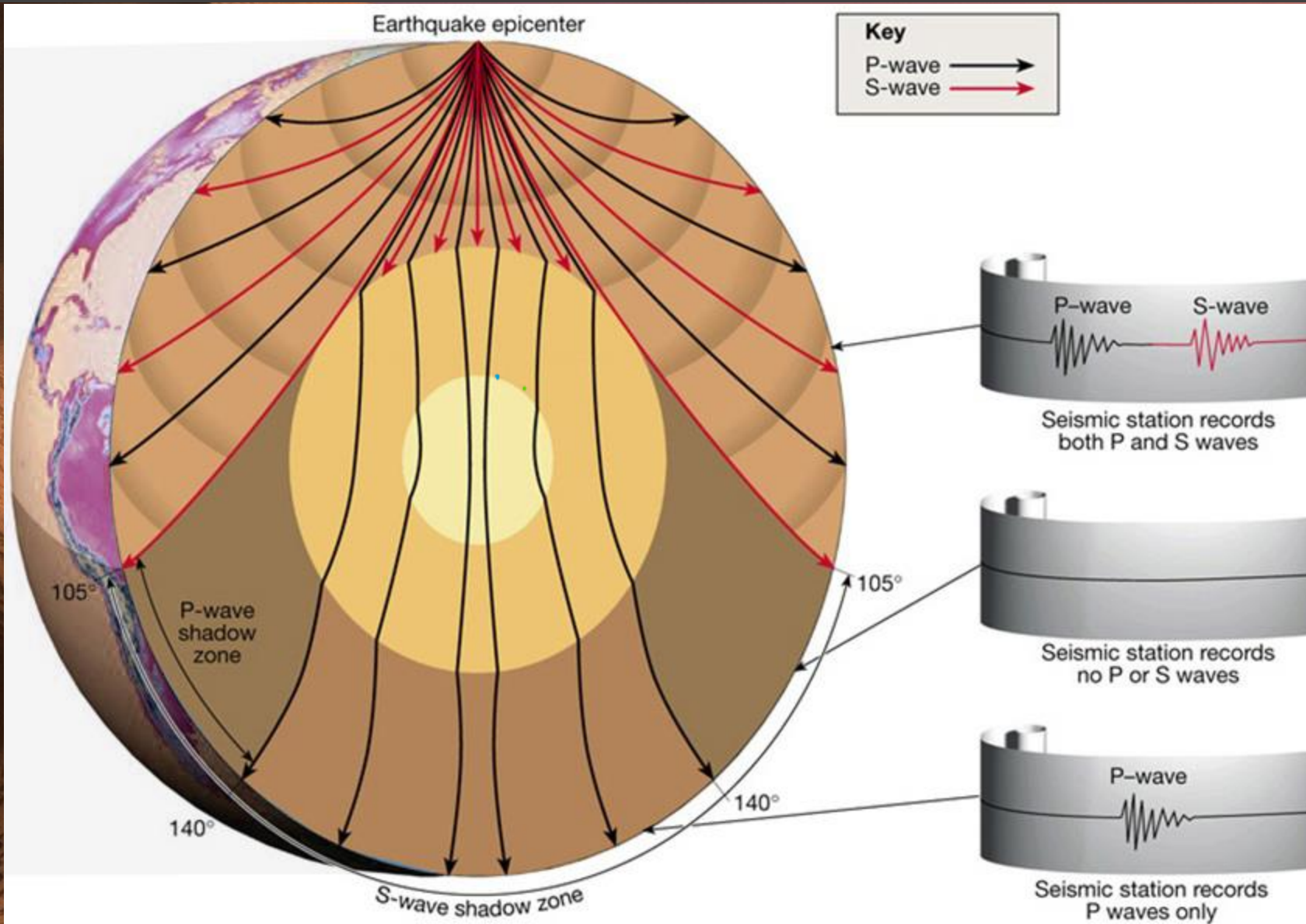




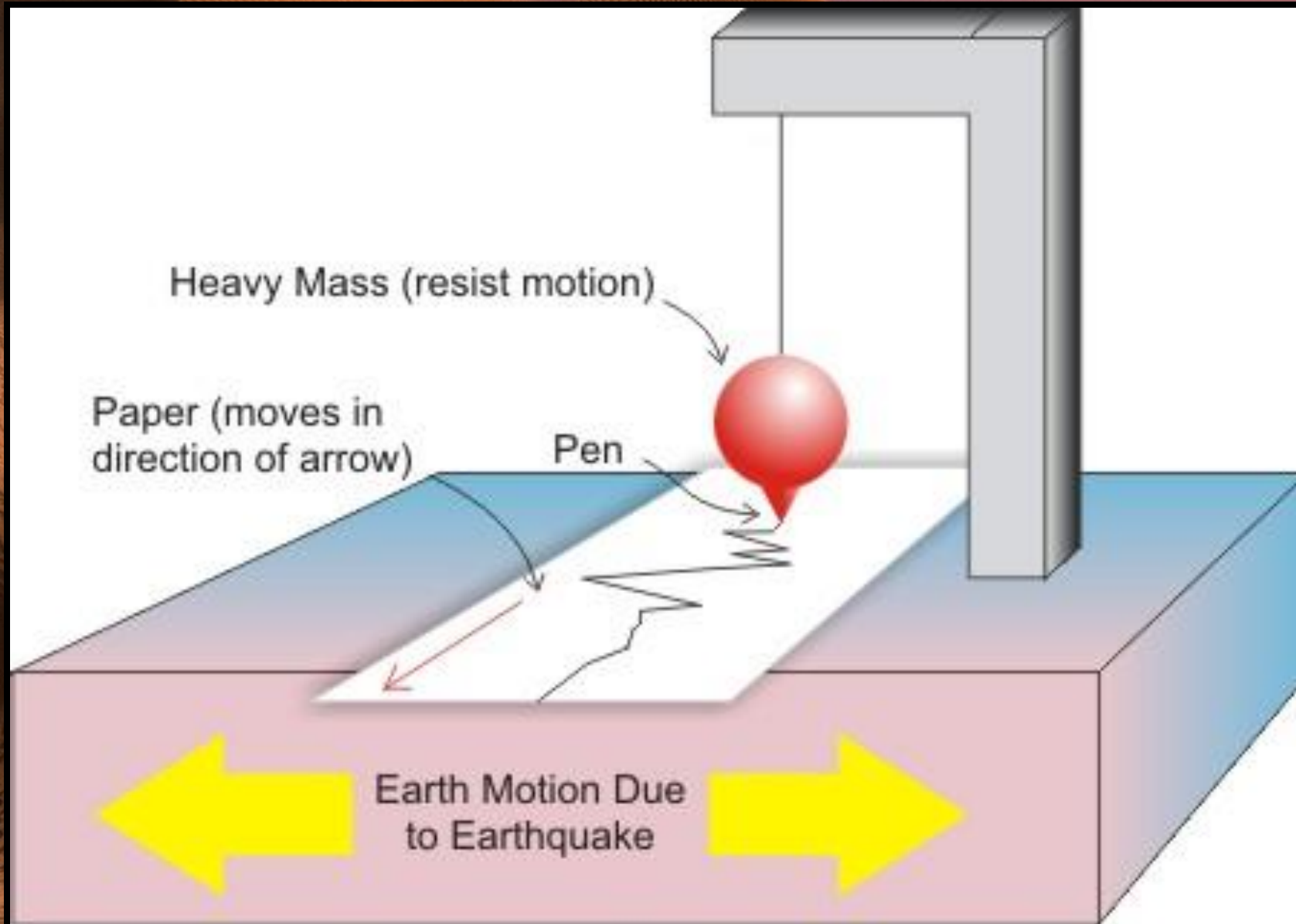


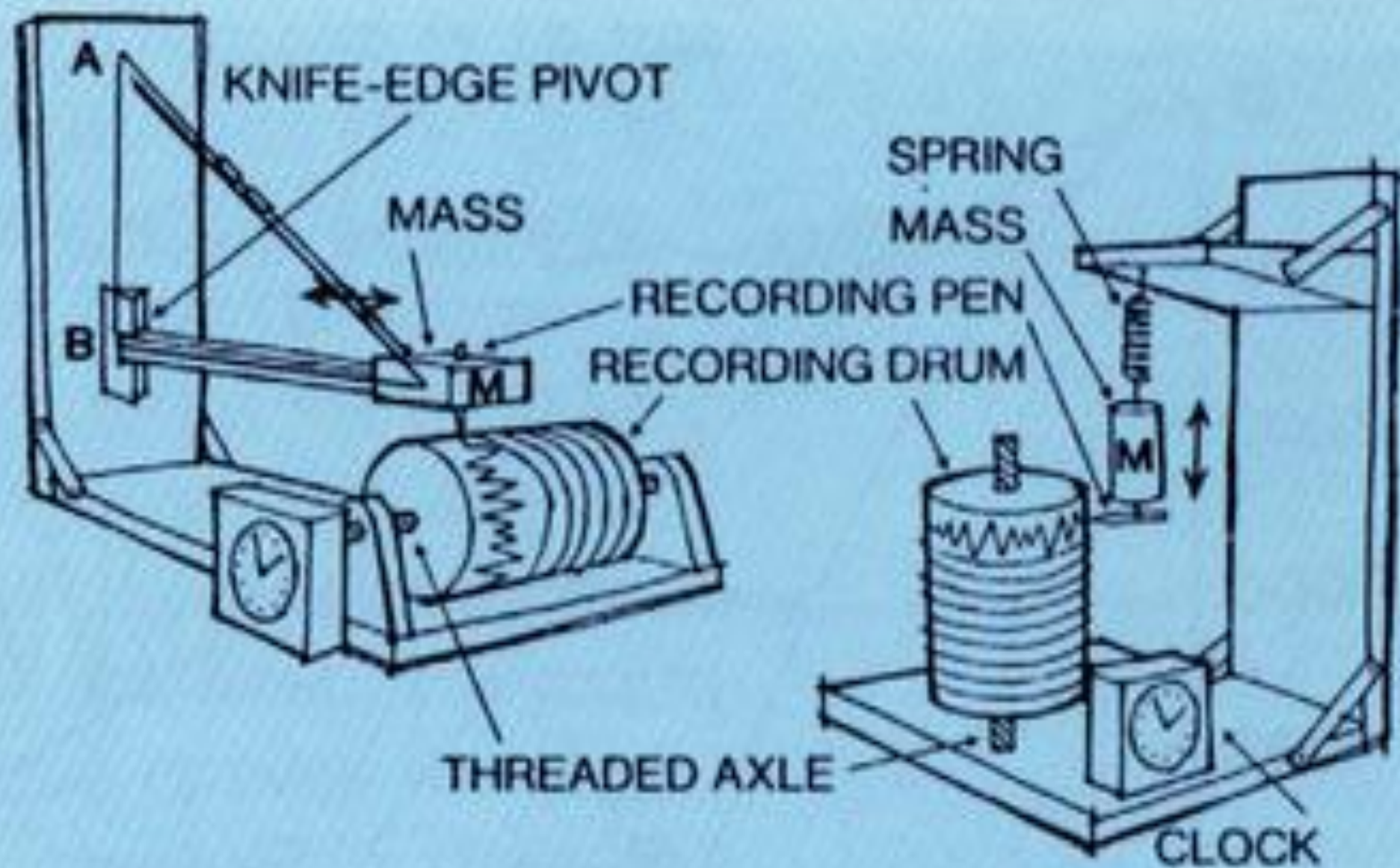


EMERGENCE OF SHADOW ZONE



Seismometer & Seismograph



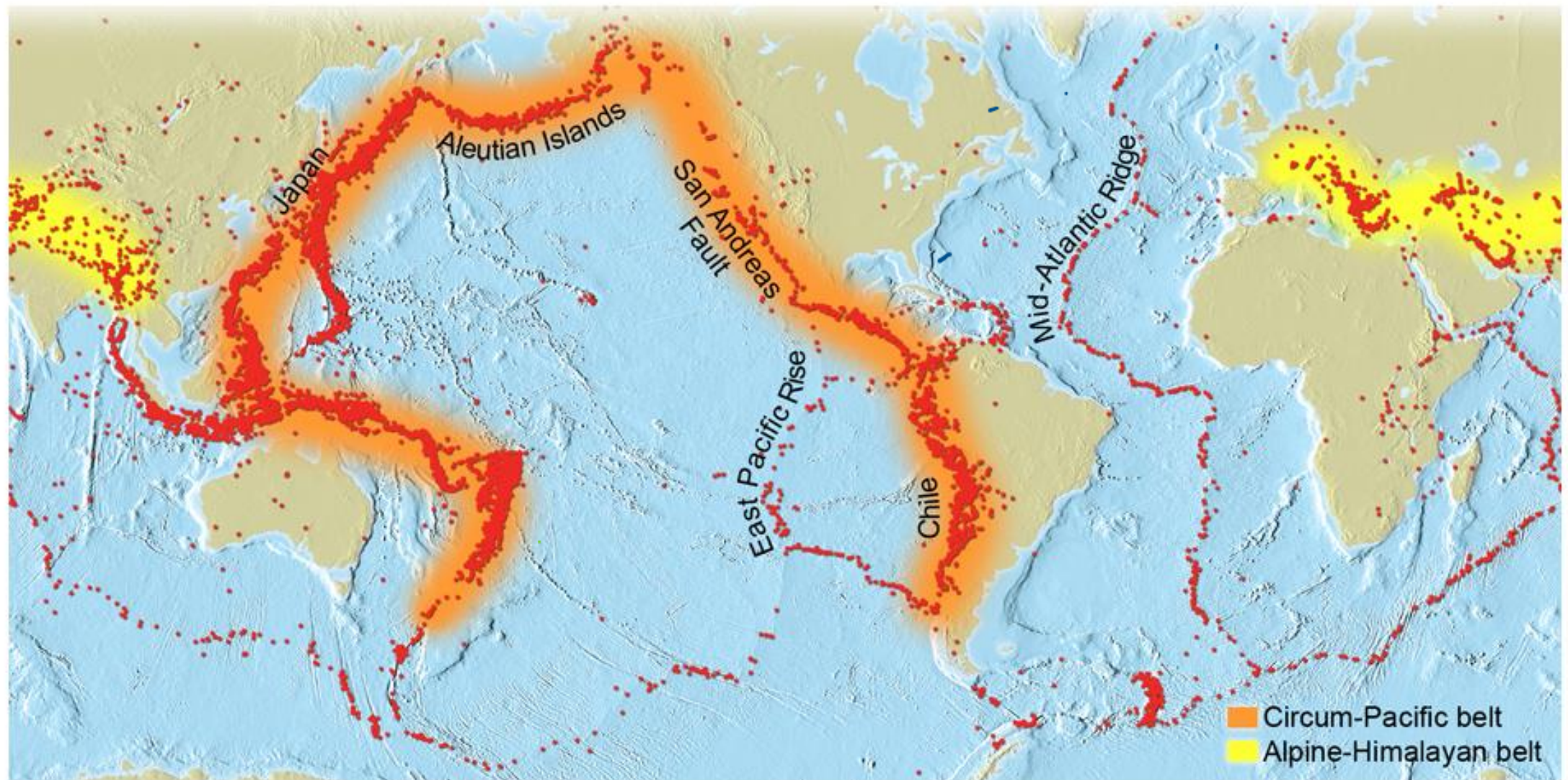


HORIZONTAL

VERTICAL

Modified Mercalli Scale		Richter Magnitude Scale
I	Detected only by sensitive instruments	1.5
II	Felt by few persons at rest, especially on upper floors; delicately suspended objects may swing	2
III	Felt noticeably indoors, but not always recognized as earthquake; standing autos rock slightly, vibration like passing truck	2.5
IV	Felt indoors by many, outdoors by few, at night some may awaken; dishes, windows, doors disturbed; autos rock noticeably	3
V	Felt by most people; some breakage of dishes, windows, and plaster; disturbance of tall objects	3.5
VI	Felt by all, many frightened and run outdoors; falling plaster and chimneys, damage small	4
VII	Everybody runs outdoors; damage to buildings varies depending on quality of construction; noticed by drivers of autos	4.5
VIII	Panel walls thrown out of frames; fall of walls, monuments, chimneys; sand and mud ejected; drivers of autos disturbed	5
IX	Buildings shifted off foundations, cracked, thrown out of plumb; ground cracked; underground pipes broken	5.5
X	Most masonry and frame structures destroyed; ground cracked, rails bent, landslides	6
XI	Few structures remain standing; bridges destroyed, fissures in ground, pipes broken, landslides, rails bent	6.5
XII	Damage total; waves seen on ground surface, lines of sight and level distorted, objects thrown up in air	7
		7.5
		8

DISTRIBUTION OF EARTHQUAKES - WORLD



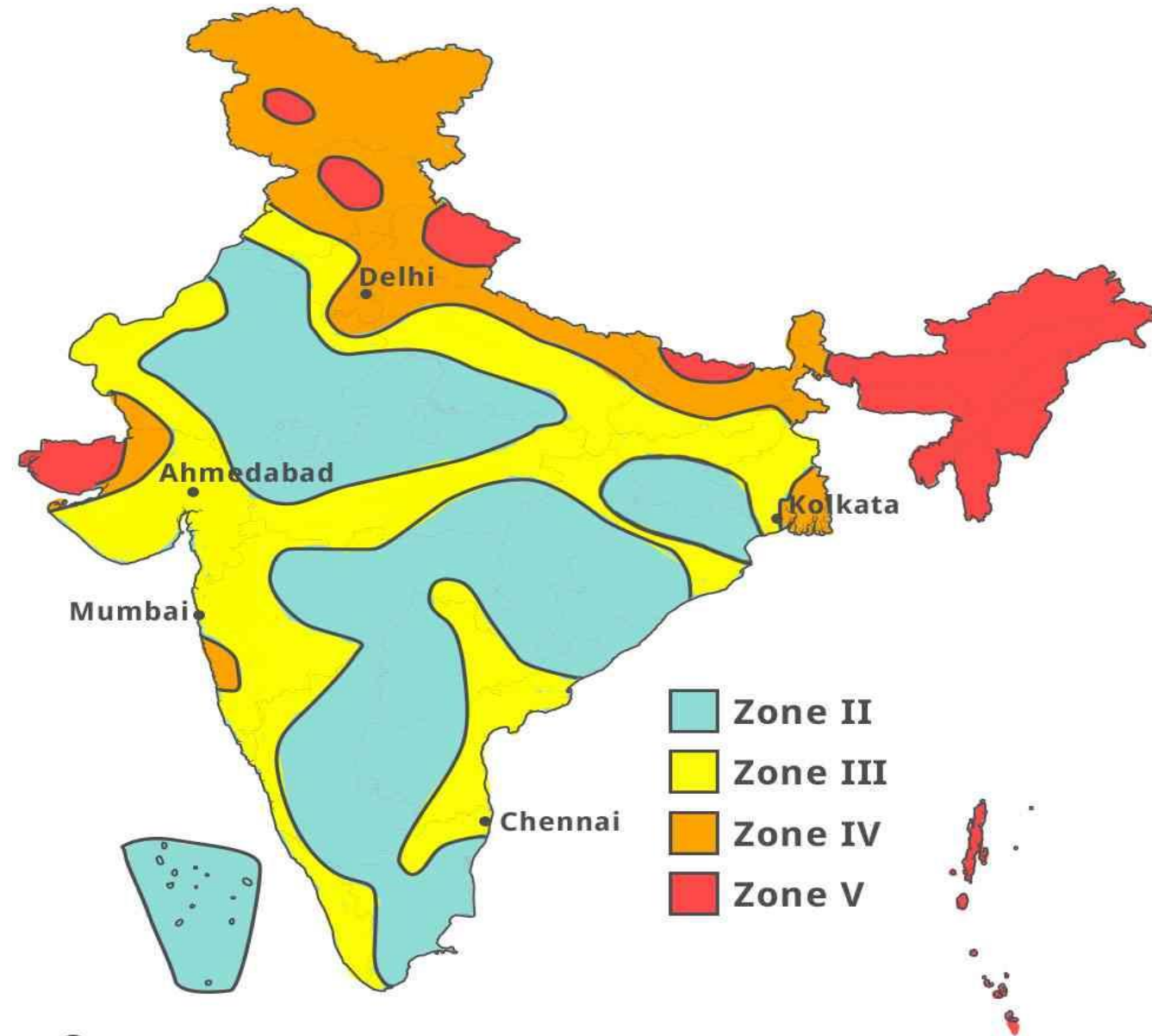
Distribution of nearly 15,000 earthquakes with magnitudes equal to or greater than 5 for a 10-year period.

© 2009 Tasa Graphic Arts, Inc.

DISTRIBUTION OF EARTHQUAKES IN INDIA

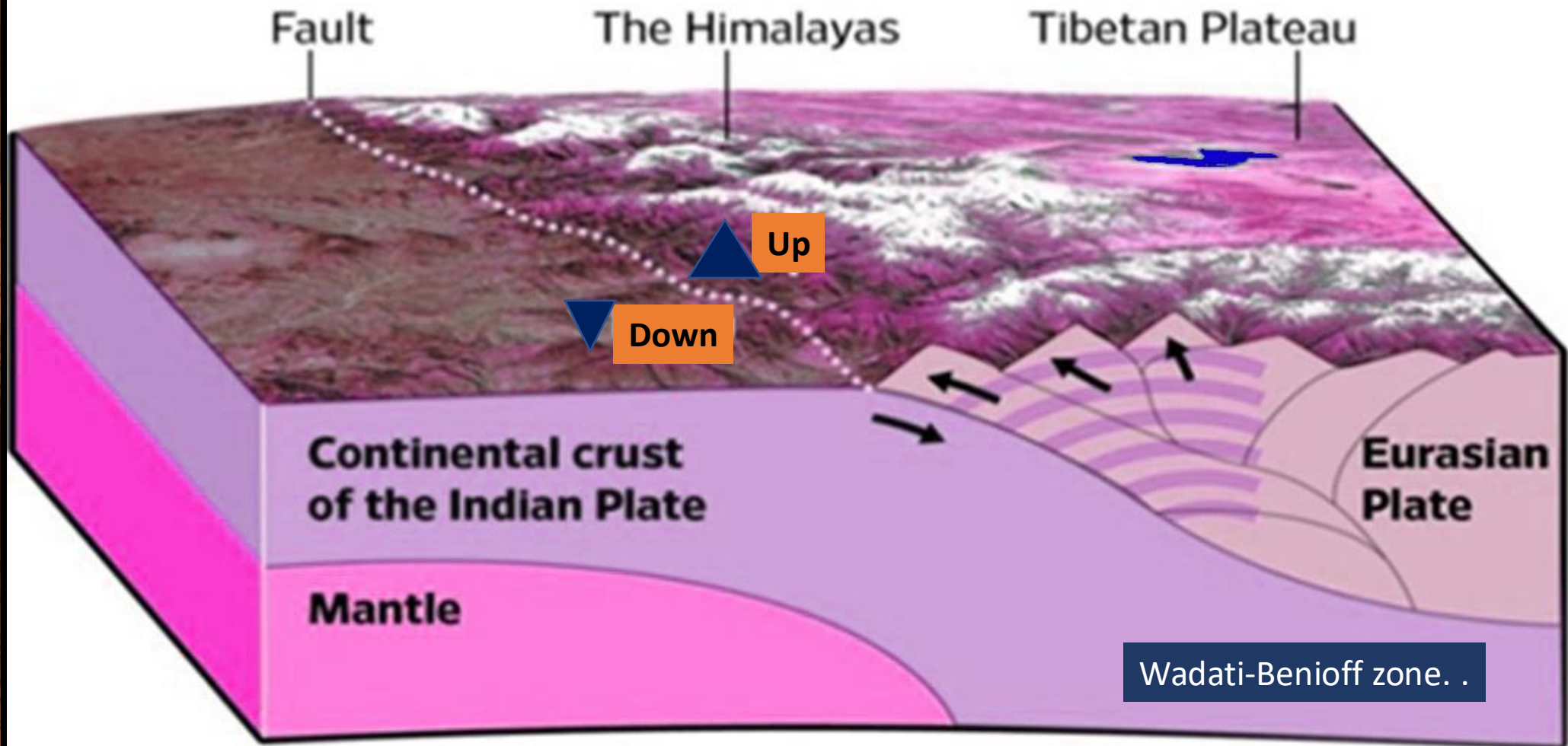
- ZONE V: Entire northeastern India, Uttarakhand, Rann of Kutch in Gujarat, some parts of Jammu and Kashmir, Himachal Pradesh, Andaman & Nicobar Islands.
- ZONE IV: Remaining parts of Jammu & Kashmir, Ladakh and Himachal Pradesh, Union Territory of Delhi, Sikkim, northern parts of Uttar Pradesh, Bihar and West Bengal, parts of Gujarat and small portions of Maharashtra near the west coast and Rajasthan.

Seismic zones in India



Continental Collision

As the Indian subcontinent pushes against Eurasia, pressure is released in the form of earthquakes. The constant crashing of the two plates forms the Himalayan mountain range.



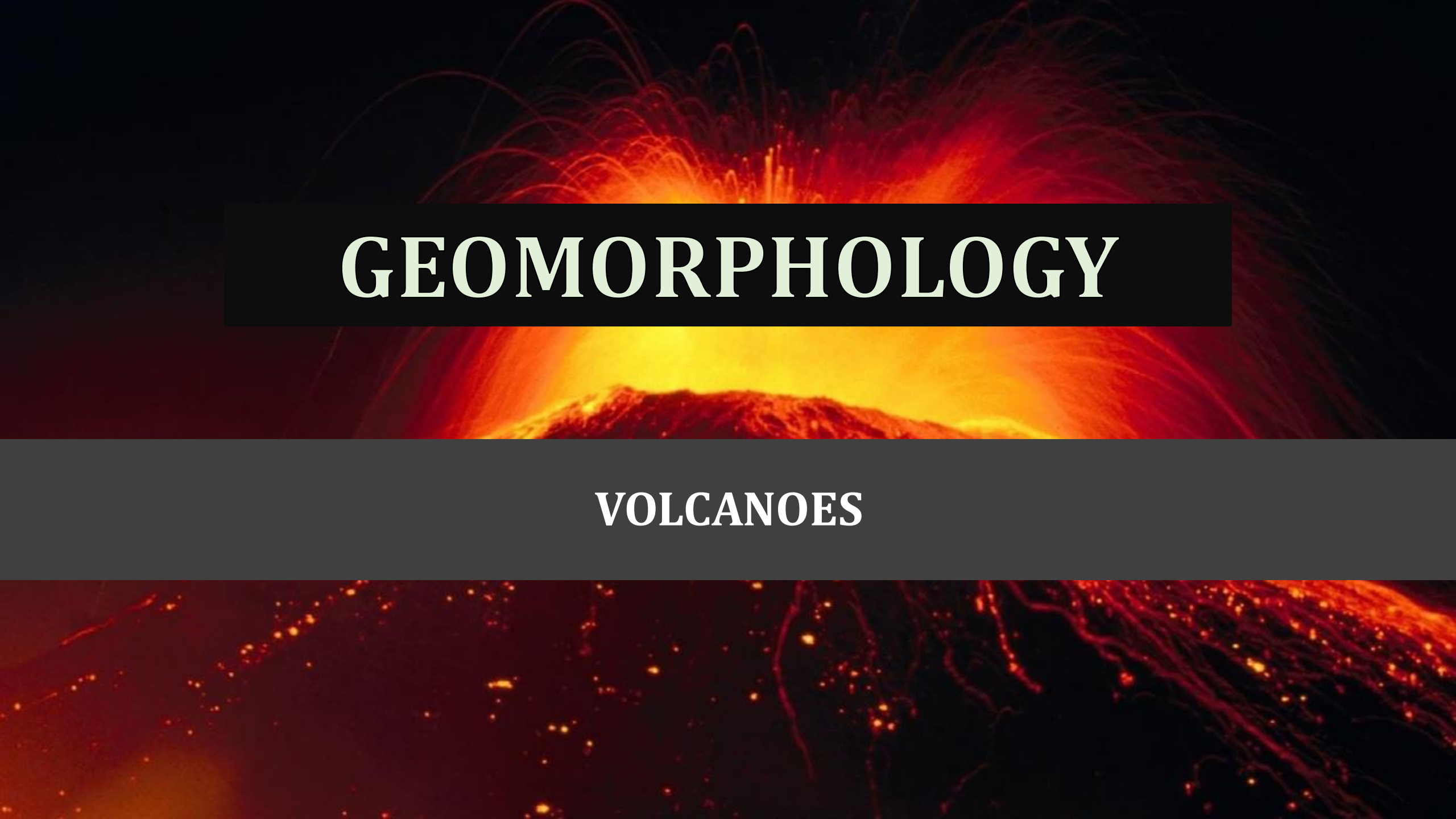
Expected Question

Consider the following statements regarding the Earthquake waves:

- I. Body waves move in all directions travelling through the interior of the earth..
- II. Primary waves are responsible for elongating and squeezing of material.
- III. Secondary waves travel only through a solid medium.

Select the wrong statement(s) using the codes given below:

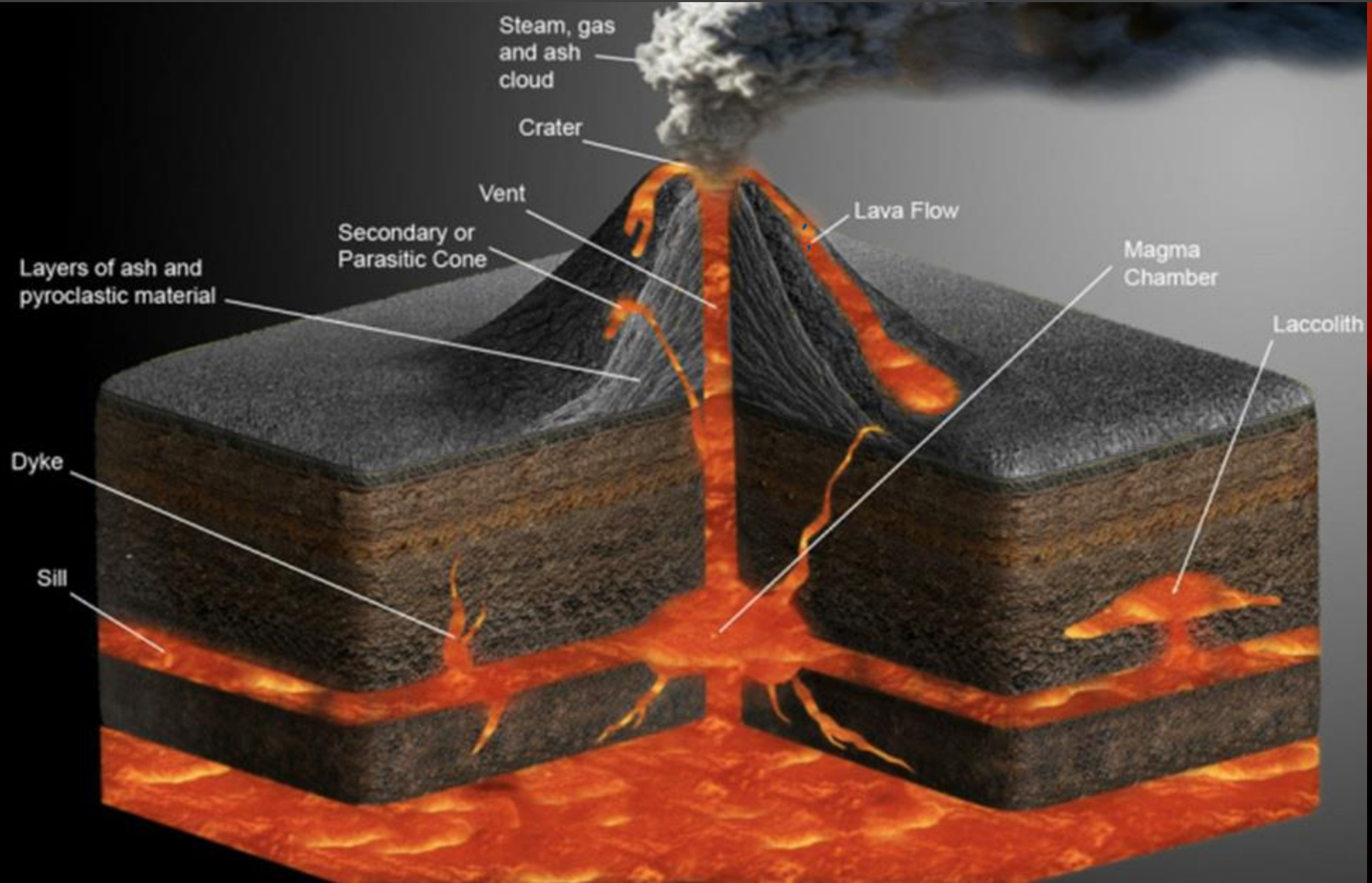
- a. I & II
- b. II & III
- c. All of the above.
- d. None of the above.

A dramatic volcanic eruption with a large plume of ash and fire. The central part of the image shows a bright yellow and orange lava flow, with a massive, dark, and billowing plume of ash and smoke rising from it. The foreground is filled with a dense field of glowing red and orange lava rocks and spatters, creating a sense of intense heat and activity. The overall scene is set against a dark, almost black background, emphasizing the fiery nature of the volcano.

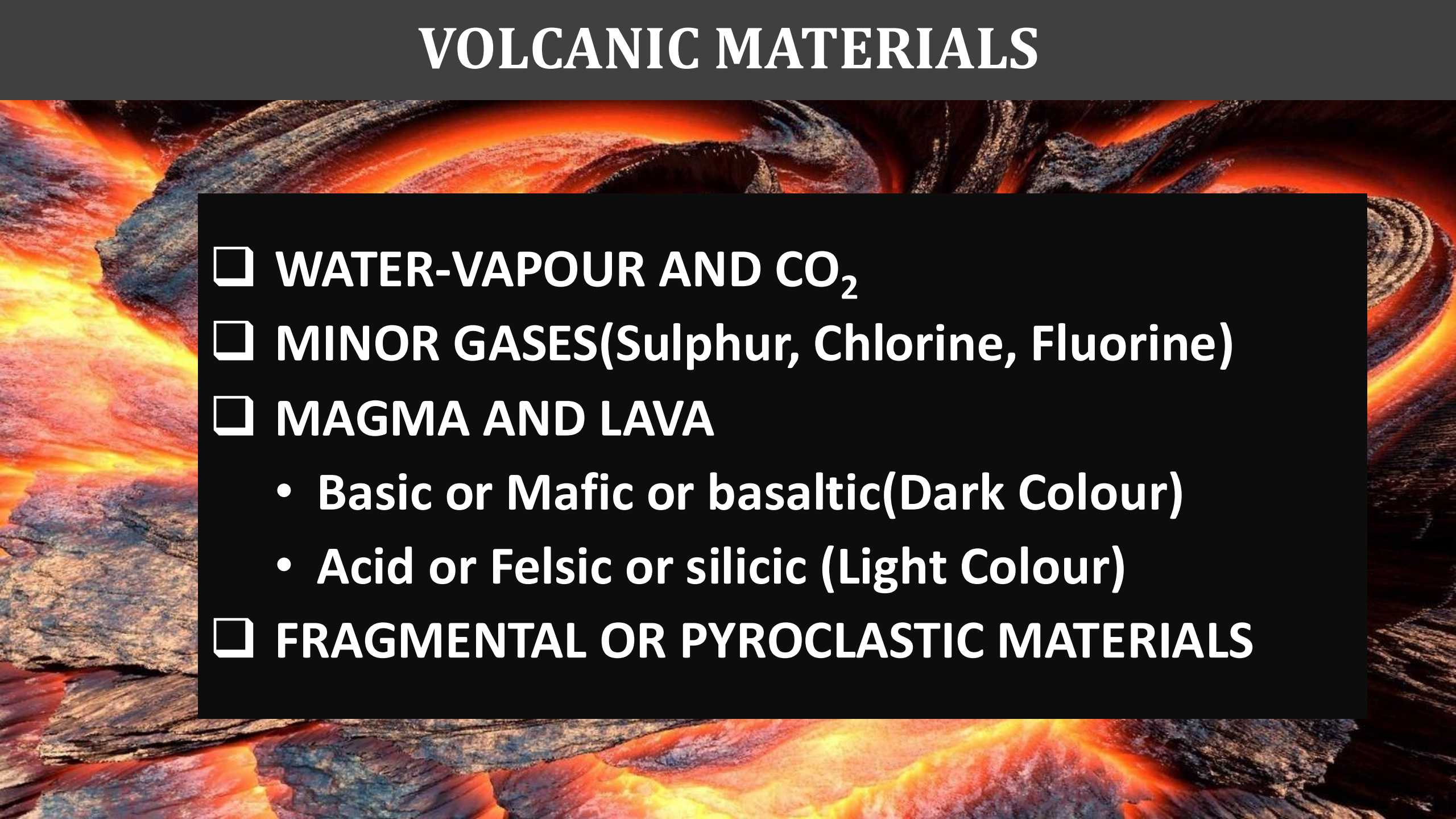
GEOMORPHOLOGY

VOLCANOES

COMPONENTS



VOLCANIC MATERIALS

- 
- ☐ WATER-VAPOUR AND CO₂
 - ☐ MINOR GASES(Sulphur, Chlorine, Fluorine)
 - ☐ MAGMA AND LAVA
 - Basic or Mafic or basaltic(Dark Colour)
 - Acid or Felsic or silicic (Light Colour)
 - ☐ FRAGMENTAL OR PYROCLASTIC MATERIALS

Volcanism Lava types

Basic or Basaltic or Shield lava

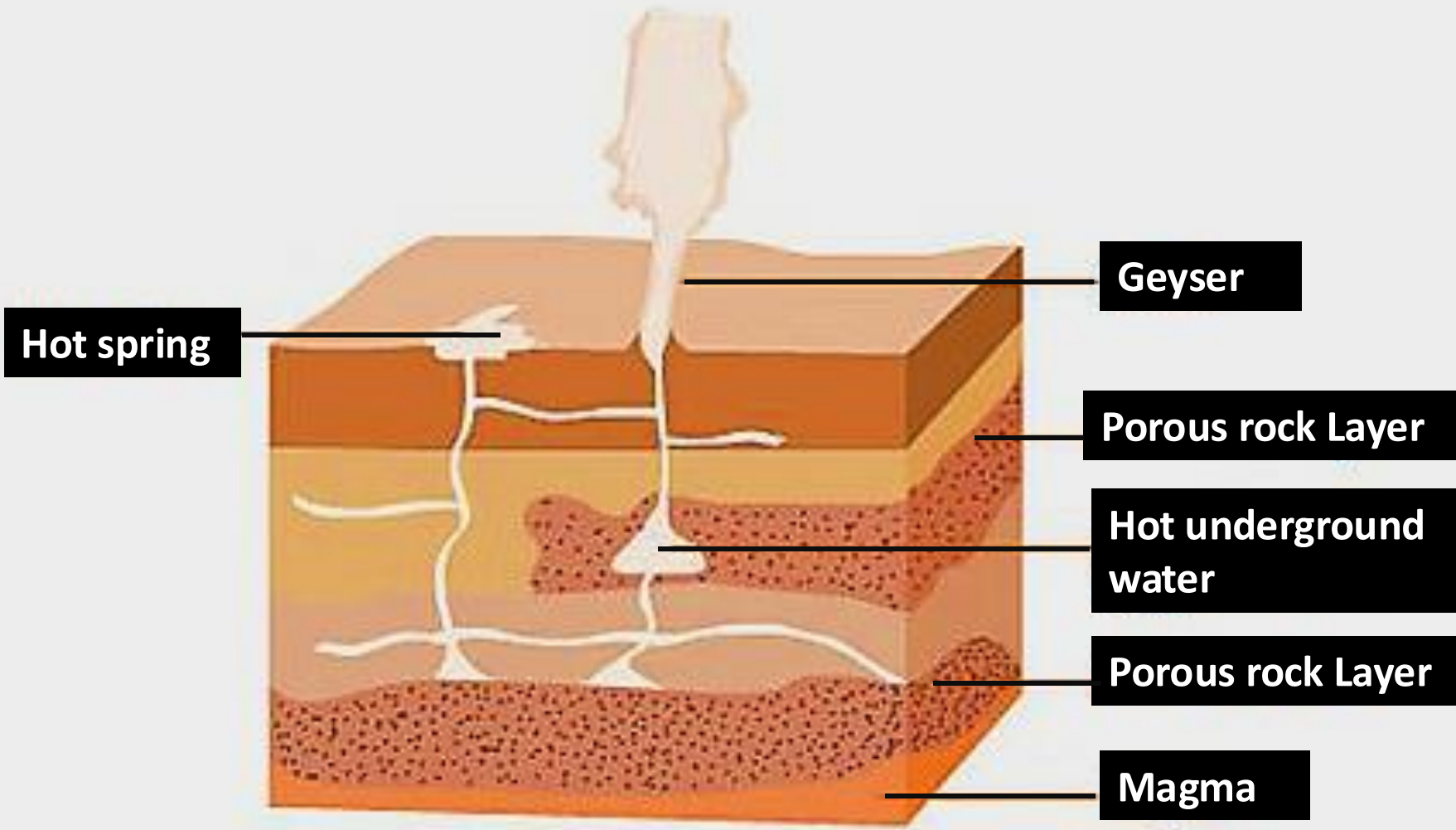
- hottest lavas,, highly fluid(10 to 30 miles per hour)
- dark coloured basalt, rich in iron and magnesium but poor in silica.
- not very explosive.
- affect extensive areas
- forms a flattened shield or dome.
- common along the **constructive boundaries** (divergent boundary).

Volcanism Lava types

Andesitic or Acidic or Composite or Stratovolcanic lava

- highly viscous
- light-coloured, of low density, and have a high percentage of silica.
- flow slowly and seldom travel far
- volcanic bombs or pyroclasts.
- Form a lava plug, Mt. Pelée in Martinique (an island in the Lesser Antilles, Caribbean Islands).
- mostly along the destructive boundaries (convergent boundaries).

GEYSERS AND HOT SPRINGS

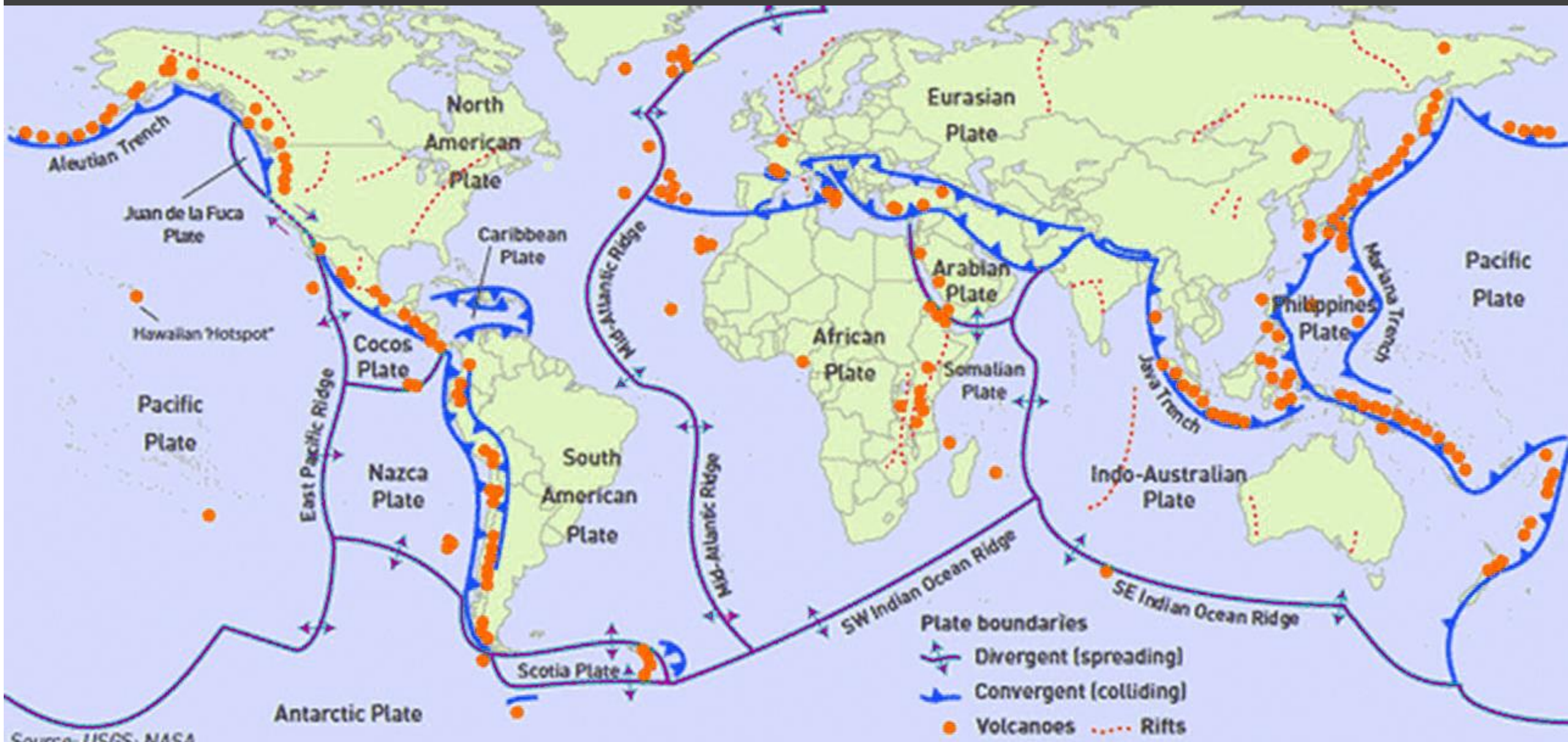


Geysers and hot Spring

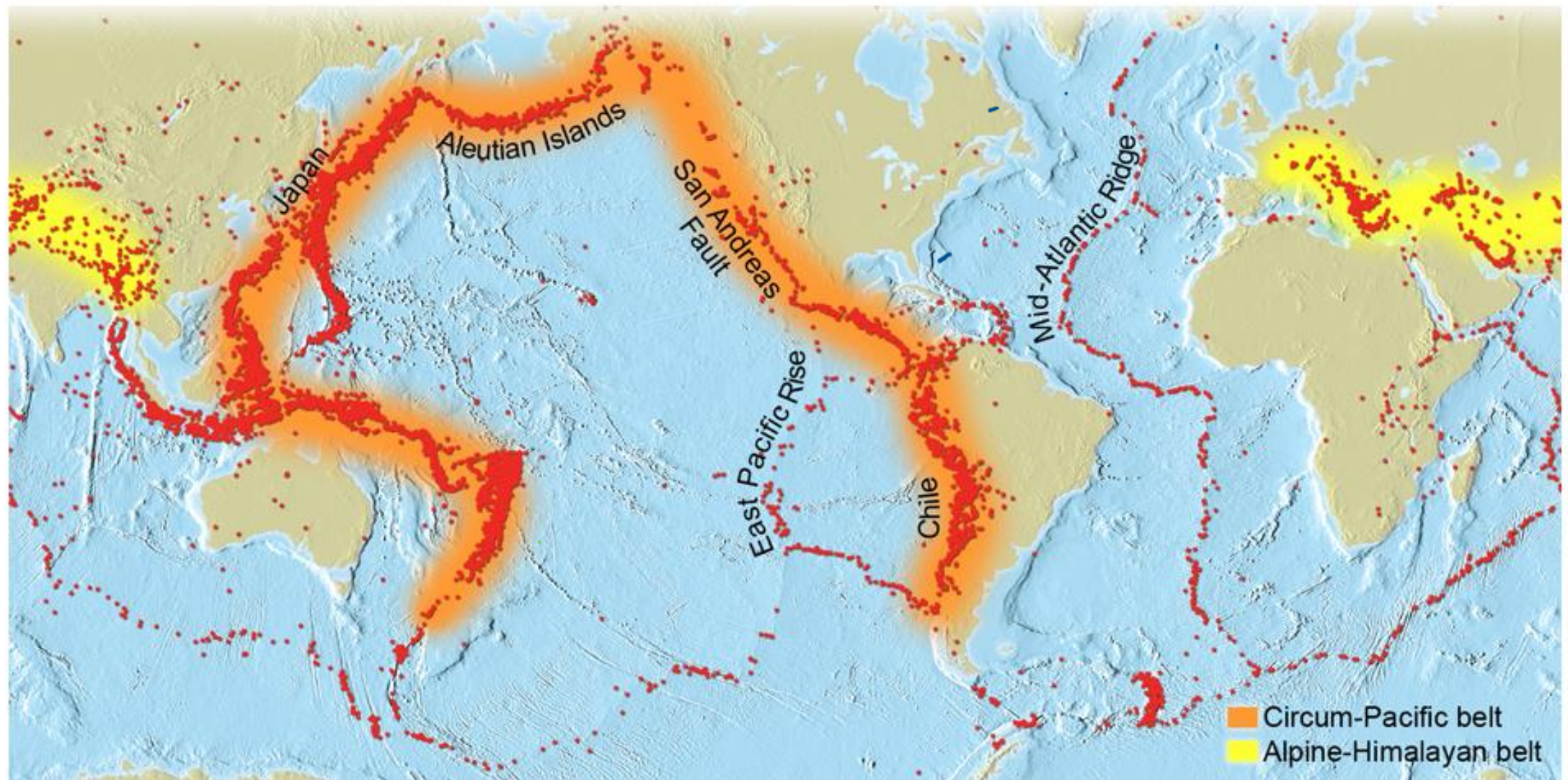




DISTRIBUTION OF VOLCANOES



DISTRIBUTION OF EARTHQUAKES - WORLD



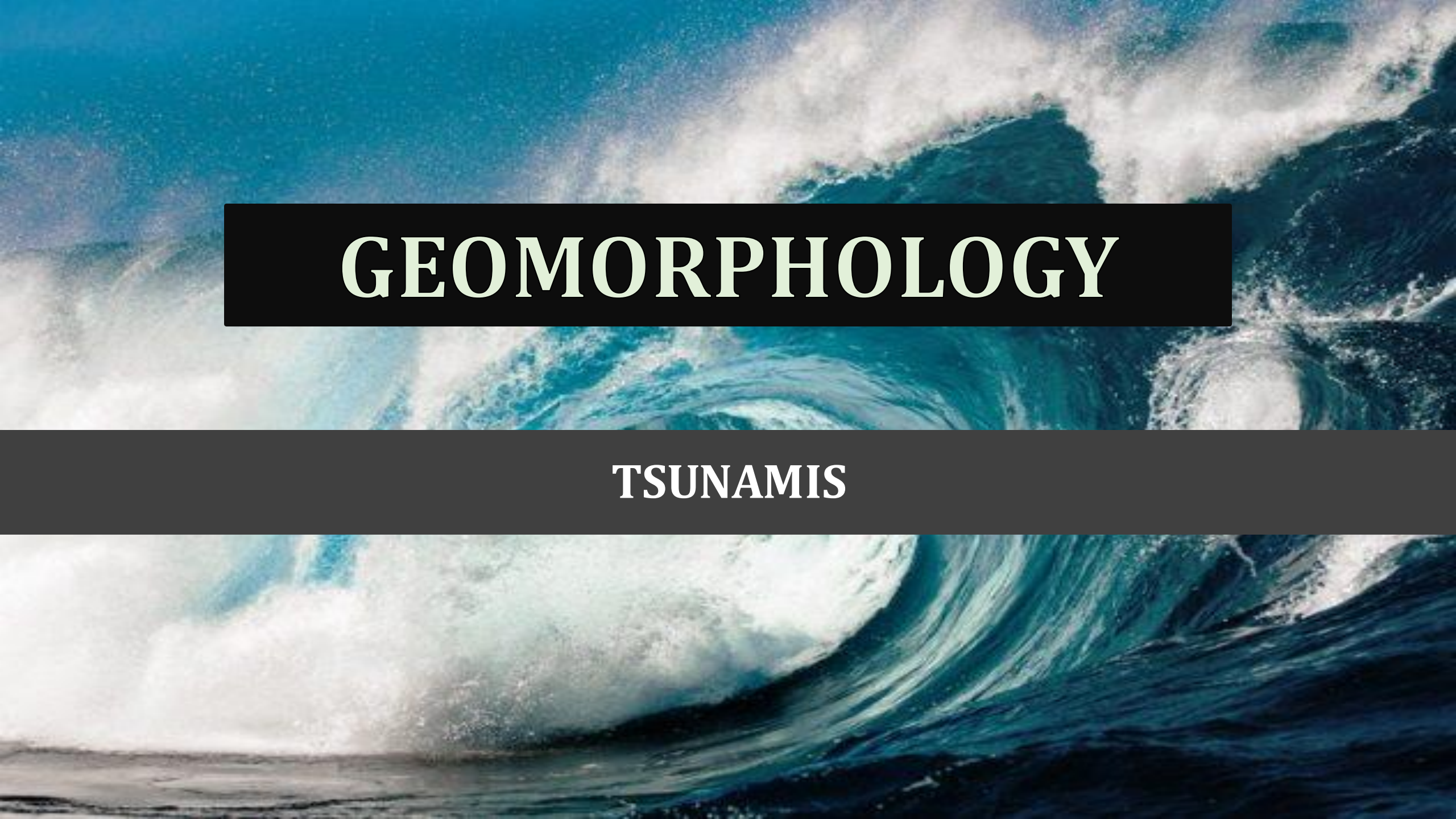
Distribution of nearly 15,000 earthquakes with magnitudes equal to or greater than 5 for a 10-year period.

Distribution of Earthquakes and Volcanoes across the World

- **Along converging plate margins and mid-oceanic ridges.**
- 70 % earthquakes occur in the Circum-Pacific belt.
- 20 % in the Mediterranean-Himalayan belt including Asia Minor, the Himalayas and parts of north-west China.

Distribution of Earthquakes and Volcanoes across the World

- ❖ 400 are located in and around the Pacific Ocean, and 80 are in the mid-world belt across the Mediterranean Sea, Alpine-Himalayan belt and in the Atlantic and Indian Oceans.
- ❖ **Aleutian-Kurile islands arc, Melanesia and New Zealand-Tonga belt.**
 - The Aleutian Islands into Kamchatka, Japan,
 - the Philippines, and Indonesia (Java and Sumatra in particular),
 - Pacific islands of Solomon, New Hebrides, Tonga and North Island, New Zealand.
 - Andes to Central America (particularly Guatemala, Costa Rica and Nicaragua), Mexico and right up to Alaska.



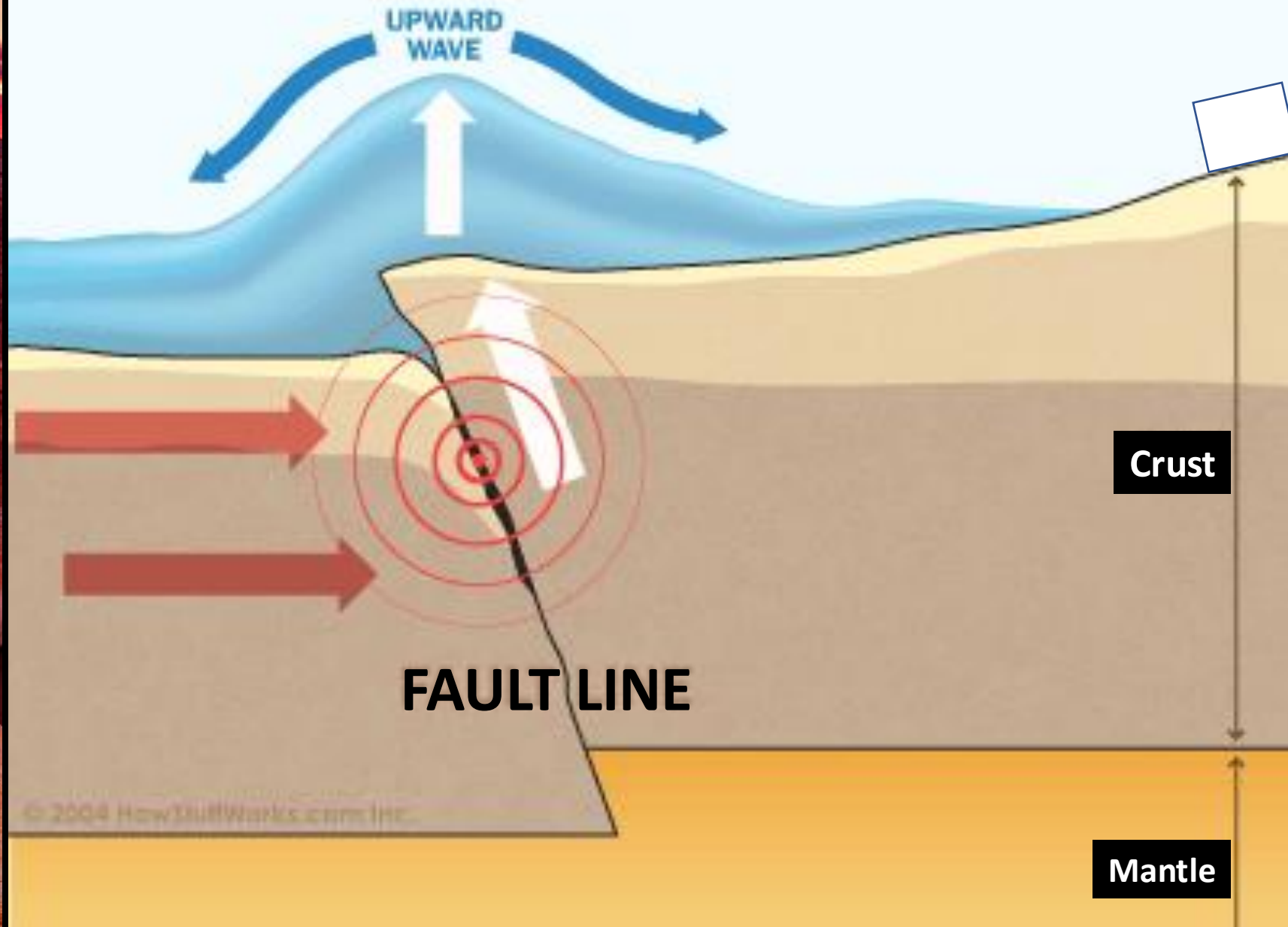
GEOMORPHOLOGY

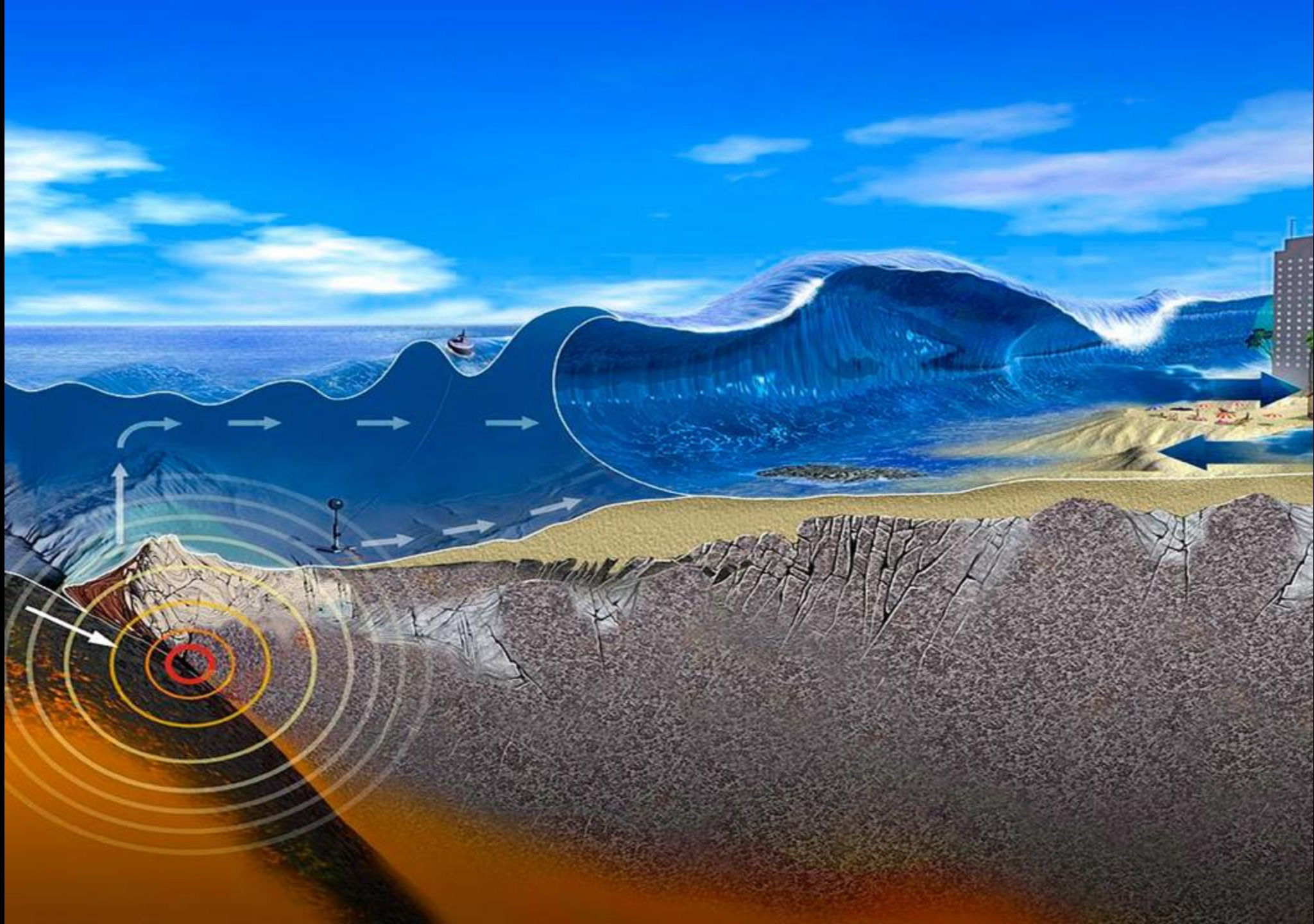
TSUNAMIS

CAUSES

- ☐ Undersea earthquake
- ☐ Volcanic eruptions
- ☐ Landslides
- ☐ Meteorites

How Tsunamis Work: Tsunamigenesis

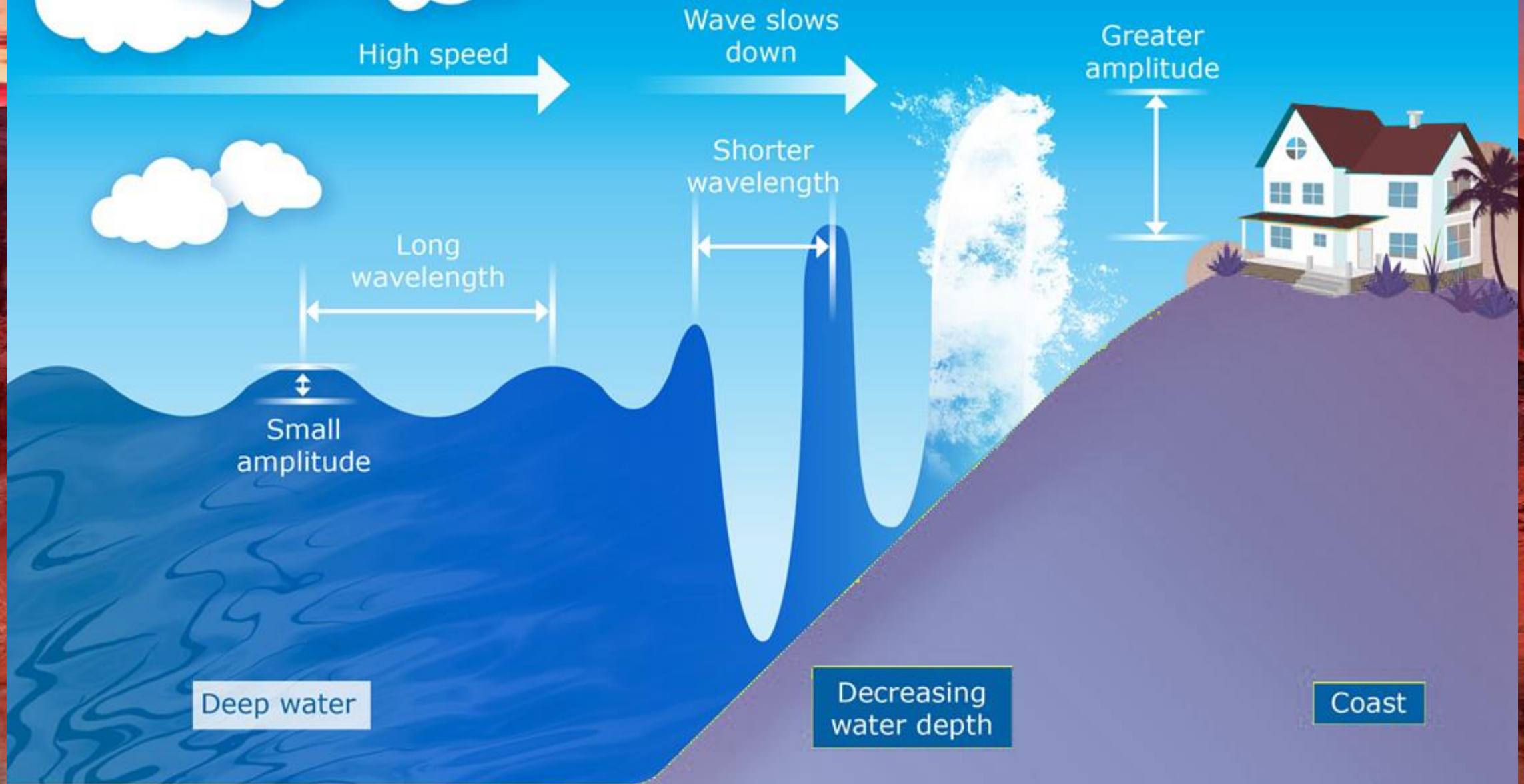




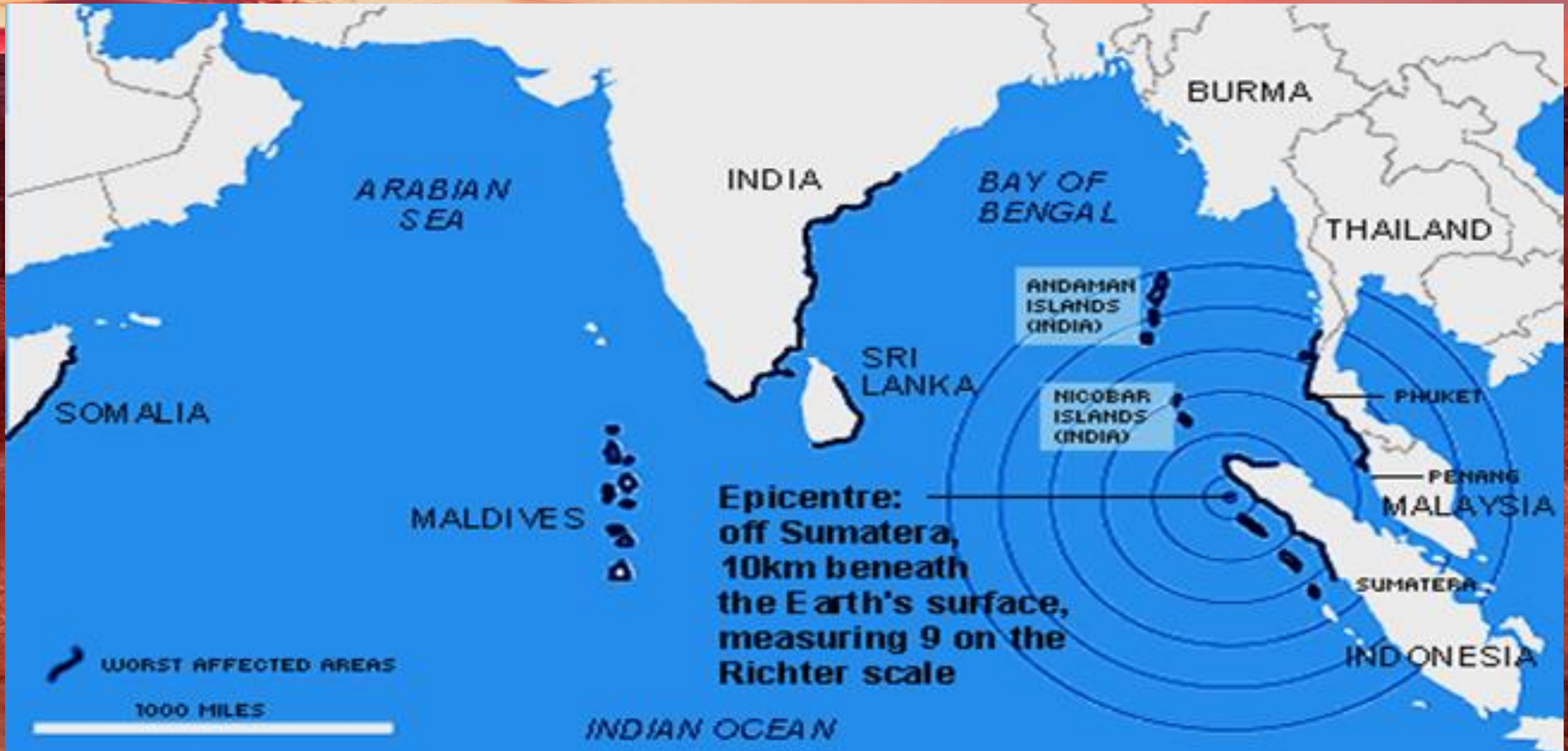
CHARACTERISTICS OF TSUNAMI

- **Tsunamis are high energy waves in the ocean.**
- **Tsunamis move unnoticed in deep sea.**
- **Tsunami waves have a slight swell of about 12 inches above the normal sea surface.**
- **Shoaling effect**
- **An approaching tsunami is sometimes preceded by a noticeable fall or rise in the water.**

SHOALING EFFECT



SUMATRA TSUNAMI



India's preparedness:

1. The Deep Ocean Assessment and Reporting System (DOARS) was set up in the Indian Ocean post-2004.
2. The Indian government plans to set up a network with Indonesia, Myanmar and Thailand etc.
3. A National Tsunami Early Warning Centre, which can detect earthquakes of more than 6 magnitude in the Indian Ocean, was inaugurated in 2007 in India.
4. Set up by the Ministry of Earth Sciences in the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad, the tsunami warning system would take 10-30 minutes to analyse the seismic data following an earthquake.

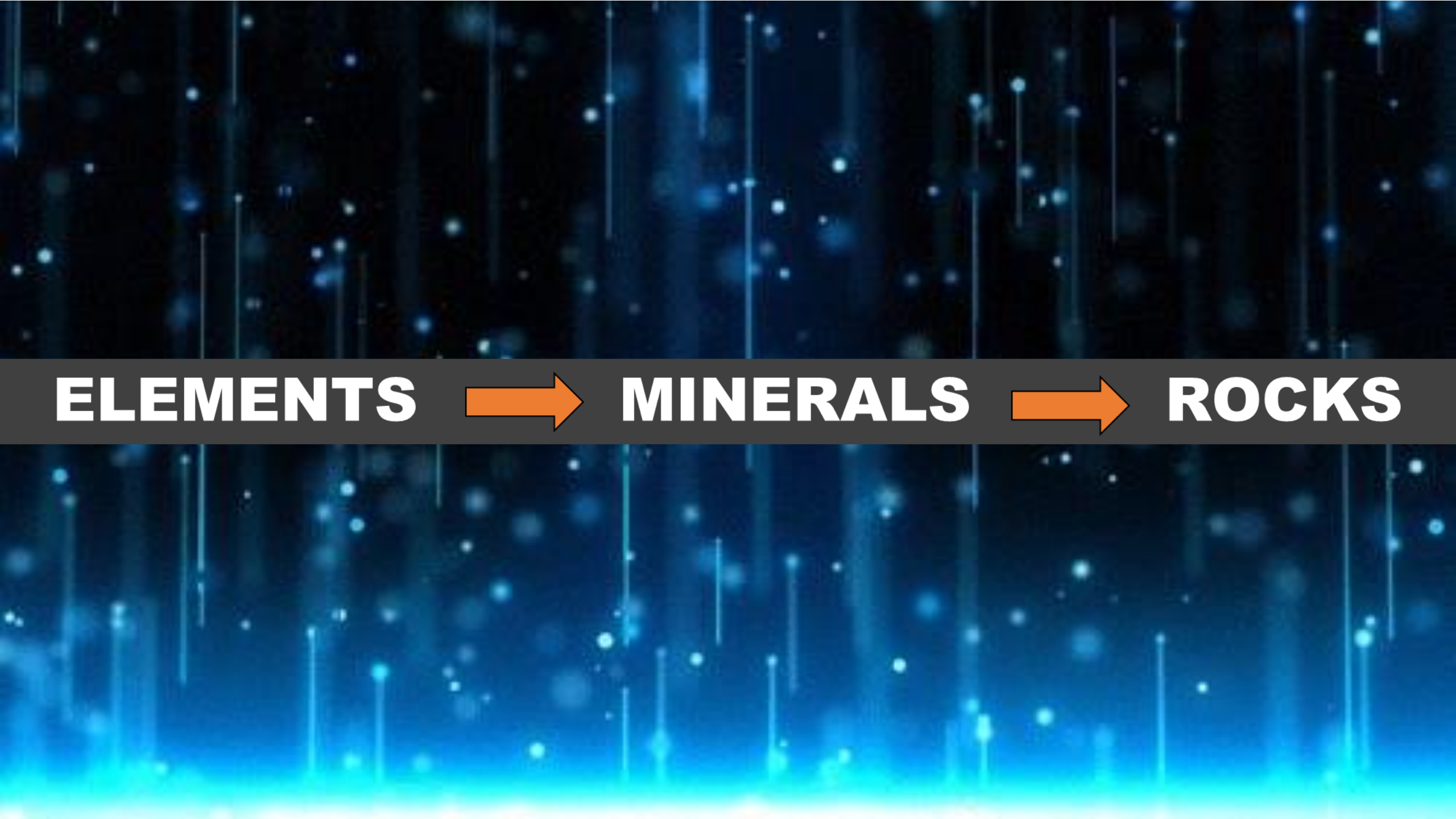
Expected Question

Which of the following statement(s) is/are true with reference to Tsunami:

- I. The effect of Tsunami occur if the epicentre of the tremor is below oceanic waters, and the magnitude is sufficiently high.
- II. Over deep water, the tsunami has very long wavelengths.
- III. Tsunamis have a small amplitude offshore.

Select the correct code:

- a. I & II
- b. II & III
- c. I & III
- d. All of the above



ELEMENTS → MINERALS → ROCKS

WHOLE EARTH

Elements	Percentage
----------	------------

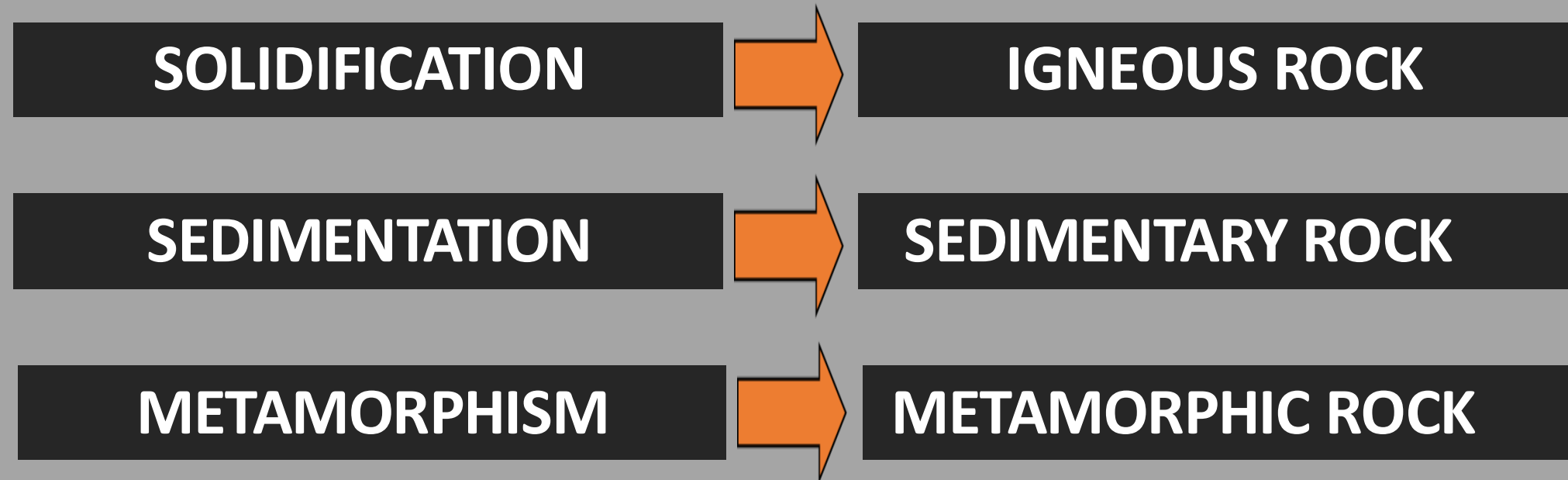
1. Iron	35
2. Oxygen	30
3. Silicon	15
4. Magnesium	13
5. Nickel	2.4
6. Sulphur	1.9
7. Calcium	1.1
8. Aluminium	1.1
Others, less than	1.0

EARTH'S CRUST

Elements	Percentage
----------	------------

1. Oxygen	46.6
2. Silicon	27.7
3. Aluminium	8.1
4. Iron	5
5. Calcium	3.6
6. Sodium	2.8
7. Potassium	2.6
8. Magnesium	2.1
Others, less than	1.4

ROCK FORMATION PROCESS



The scientific study of rocks is called **petrology**

Igneous (Plutonic rocks)

Formed from the
cooling & solidification of
lava or Magma.

Intrusive (Plutonic rocks)

1. Formed inside the
earth from Magma

2. Magma cools
slowly

3. Large crystal formed.(any
crystal larger than 1 mm
are Intrusive rocks)

Extrusive (Lava or Volcanic rocks)

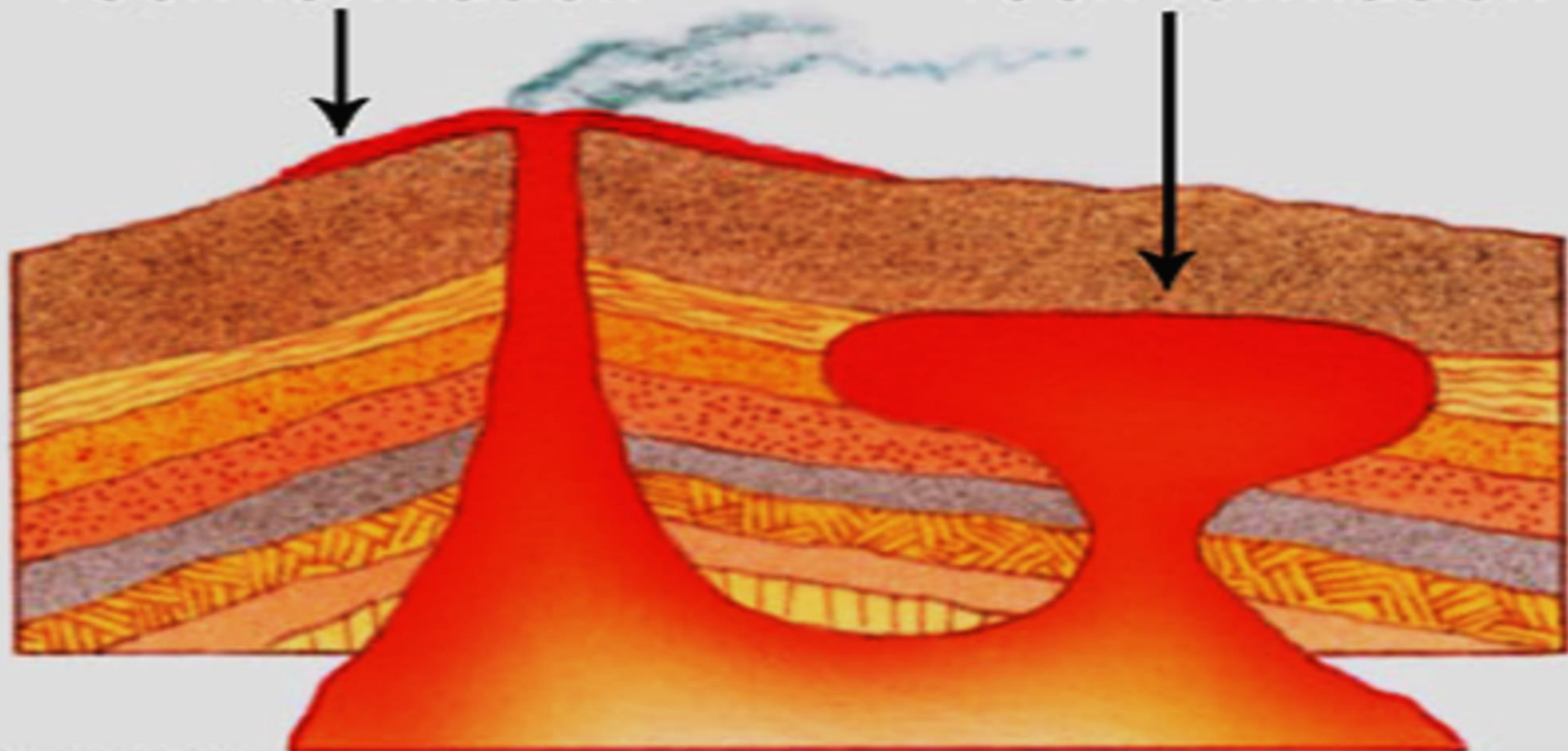
1. Lava cools
quickly.

2. Small or no
crystal formed.

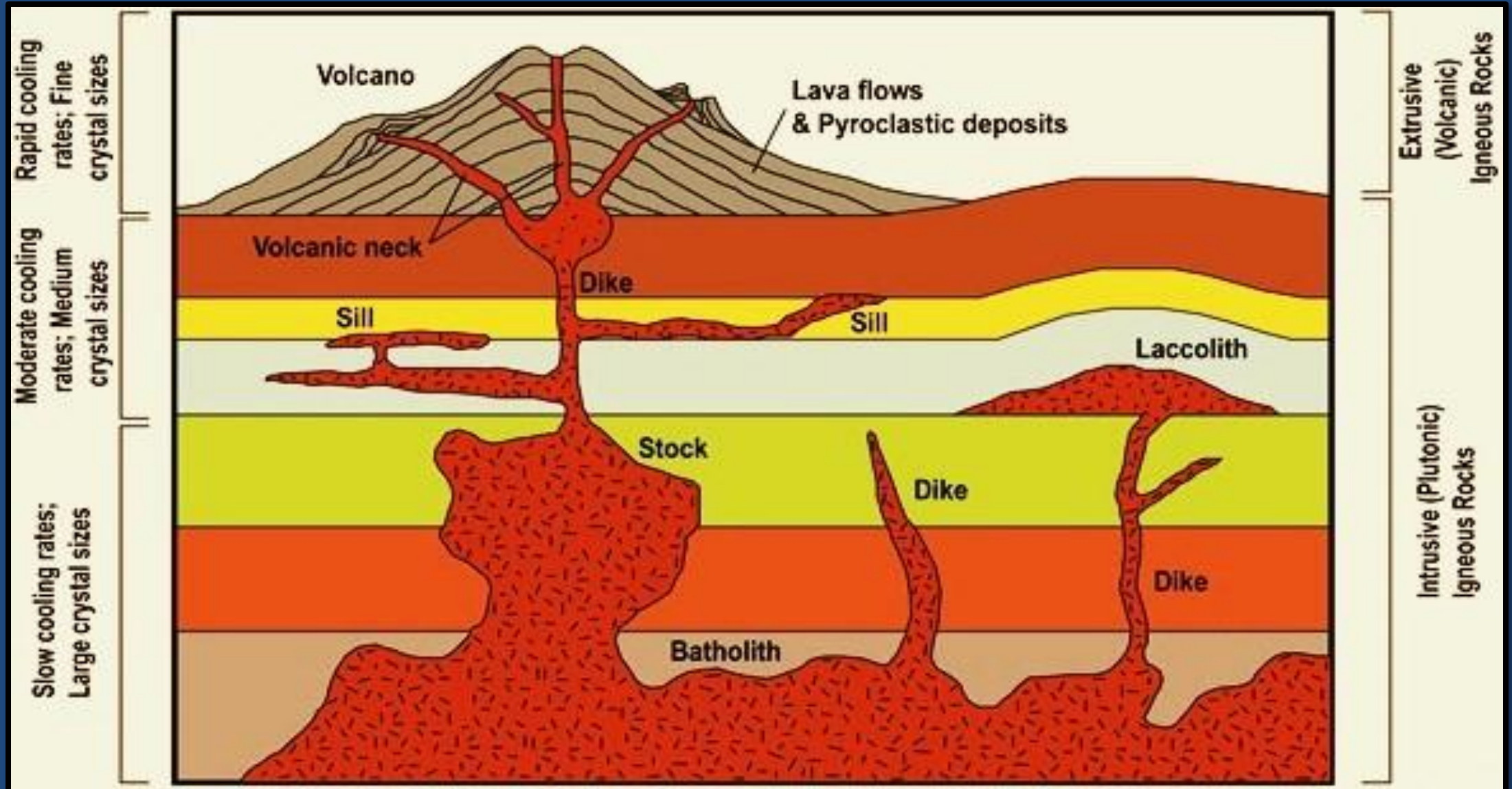
3. May be vesicular.
4. Contains air bubbles.

**Extrusive igneous
rock formation**

**Intrusive igneous
rock formation**

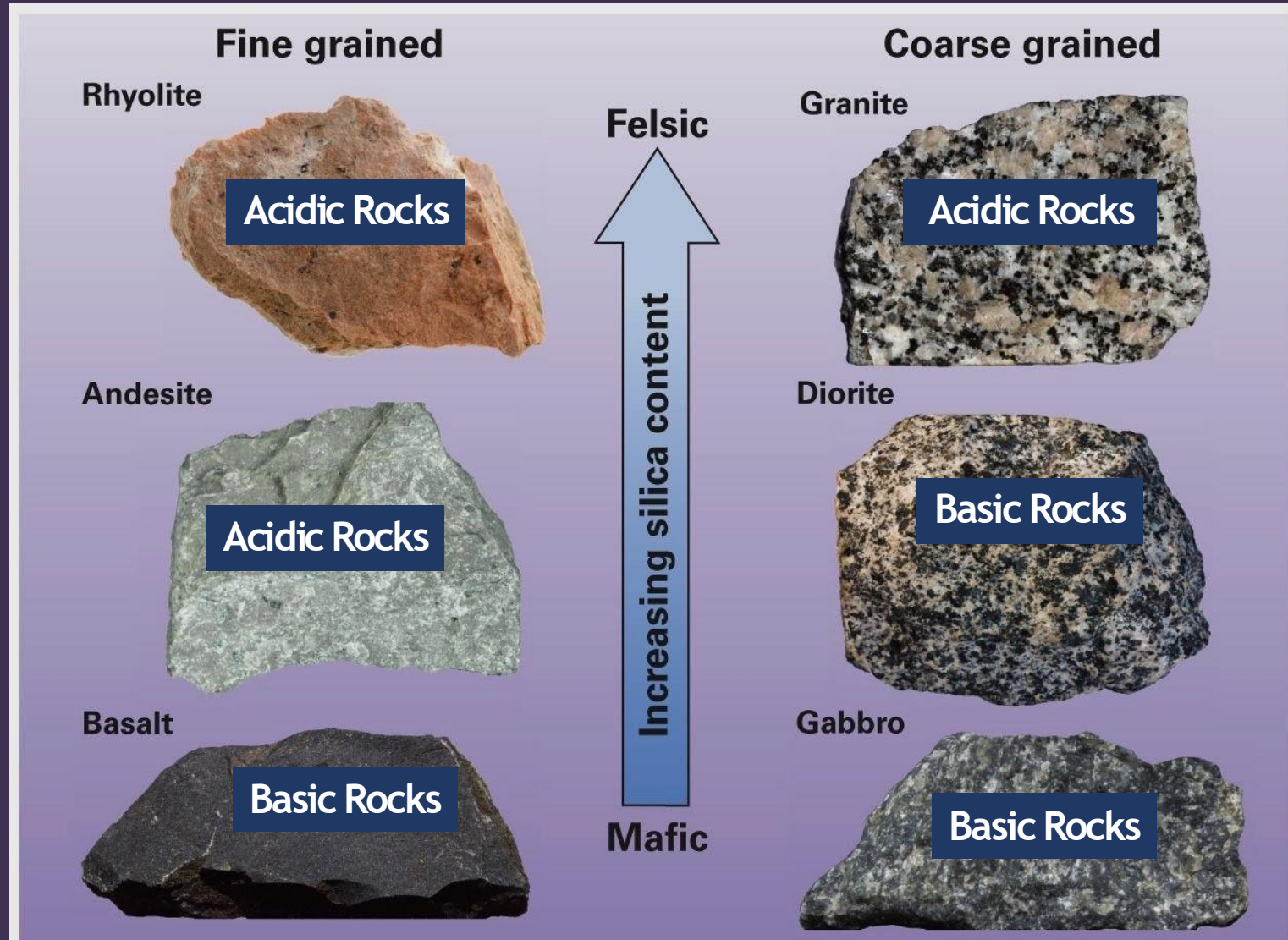


Hypabyssal or Dyke Rocks or Intermediate rocks



CHARACTERISTICS OF IGNEOUS ROCKS

- ❖ Hard Rocks
- ❖ Water Penetrates with Great Difficulty
- ❖ Granular or Crystalline Rocks
- ❖ No Strata/layers
- ❖ They are Less Affected by Chemical Weathering (Except Basalts)
- ❖ No Fossils



Economic Significance of Igneous Rocks

- Since magma is the chief source of metal ores, many of them are associated with igneous rocks.
- The minerals of great economic value found in igneous rocks are magnetic iron, nickel, copper, lead, zinc, chromite, manganese, gold, diamond and platinum.
- Amygdales are almond-shaped bubbles formed in basalt due to escape of gases and are filled with minerals.
- The old rocks of the great Indian peninsula are rich in these crystallised minerals or metals.
- Many igneous rocks like granite are used as building materials as they come in beautiful shades.

Expected Question

Which of the following statement(s) is/are true regarding Igneous Rocks:

- I. Igneous rocks solidify from magma and lava.
- II. Igneous rocks are nonfossiliferous.
- III. They form under conditions of high temperatures.

Choose the correct statement(s) using the codes given below:

- a. I Only
- b. II and III
- c. I and III
- d. I, II and III

CHARACTERISTICS OF SEDIMENTARY ROCKS

- ❖ Made of sediments
- ❖ Largest surface areas
- ❖ Layered in structure
- ❖ Contains fossils
- ❖ Not massive forms
- ❖ Deformed formations



Sedimentary Lithification of Rocks

Mechanically

running water,
wind, ocean
currents

Arenaceous
(hard and porous)

Argillaceous
(mostly impermeable)

Chemically

Evaporates

Precipitates

**Stalactites and
stalagmites**

Organically

**3. Biological
Matter.**

**heat and
pressure**

**Coal and
limestone**

Economic Significance of Sedimentary Rocks

- Sedimentary rocks are not as rich in minerals of economic value as the igneous rocks.
- But important minerals such as hematite iron ore, phosphates, building stones, coals, petroleum and material used in the cement industry are found.
- The decay of tiny marine organisms yields petroleum. Petroleum occurs in suitable structures only.
- Important minerals like bauxite, manganese, tin, are derived from other rocks but are found in gravels and sands carried by water.
- Sedimentary rocks also yield some of the richest soils.

METAMORPHIC ROCKS

❖ *DYNAMIC METAMORPHISM*

- Granite → Gneiss
- Clay and shale → Schist

❖ *THERMAL METAMORPHISM*

- Sandstone → Quartzite
- Clay and shale → Slate
- Limestone → Marble
- Coal → Anthracite and graphite

Examples of Metamorphic Rocks



Gneiss



Slate



Quartzite



Schist



Marble



Phyllite

Metamorphic

(Changes of state by heat, pressure)

**Thermal
Metamorphism**



**Contact
Metamorphism**



**Contact by
Heat**

**Dynamic
Metamorphism**



**Regional
Metamorphism**



**Contact by
Pressure**

Expected Question

Consider the following statements with reference to the Earth's crust:

- I. The crust is the outermost solid part of the earth.
- II. The continental crust is mainly formed by basaltic rocks.
- III. The oceanic crust are mainly formed by granitic rocks.

Which of the following statements is/are NOT correct:

- a. I Only
- b. II and III
- c. I and III
- d. I, II and III

Expected Question

Which of the following statement(s) is/are true regarding Sedimentary Rocks:

- I. Sedimentary rocks have layers or stratifications of varying thickness.
- II. Sedimentary rocks are formed by mechanical agents like running water, wind, ocean currents, ice, etc.

Choose the correct statement(s) using the codes given below:

- a. I Only
- b. II Only
- c. Both I and II
- d. None of the above.

Rock-Forming Minerals

Feldspar:

Quartz:

Bauxite:

Cinnabar (mercury
sulphide):

Dolomite:

Gypsum:

Haematite:

Magnetite:

Amphibole:

Mica:

Olivine:

Pyroxene:

Chlorite:

calcite:

magnetite:

hematite:

bauxite:

Barite:

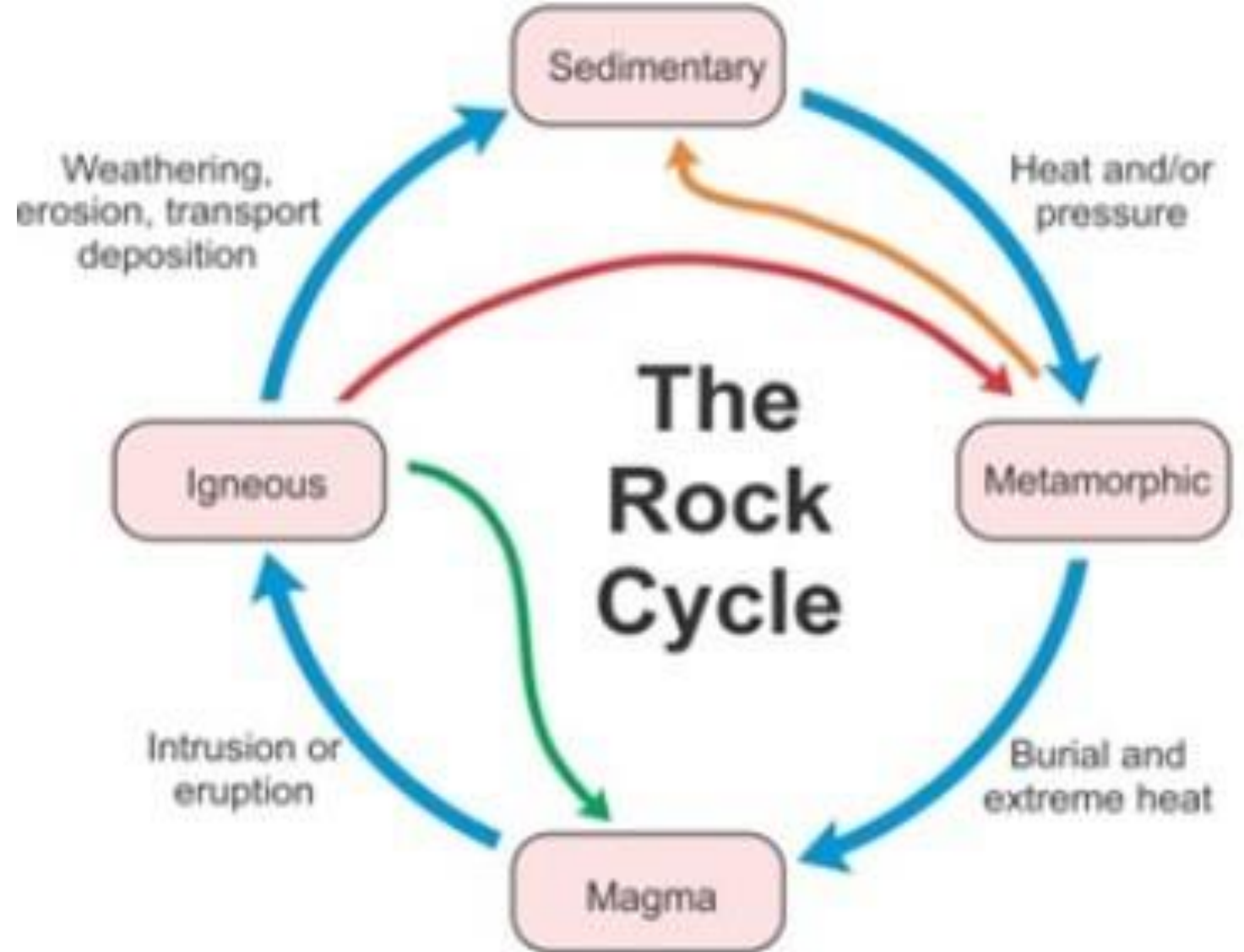
Rock-Forming Minerals

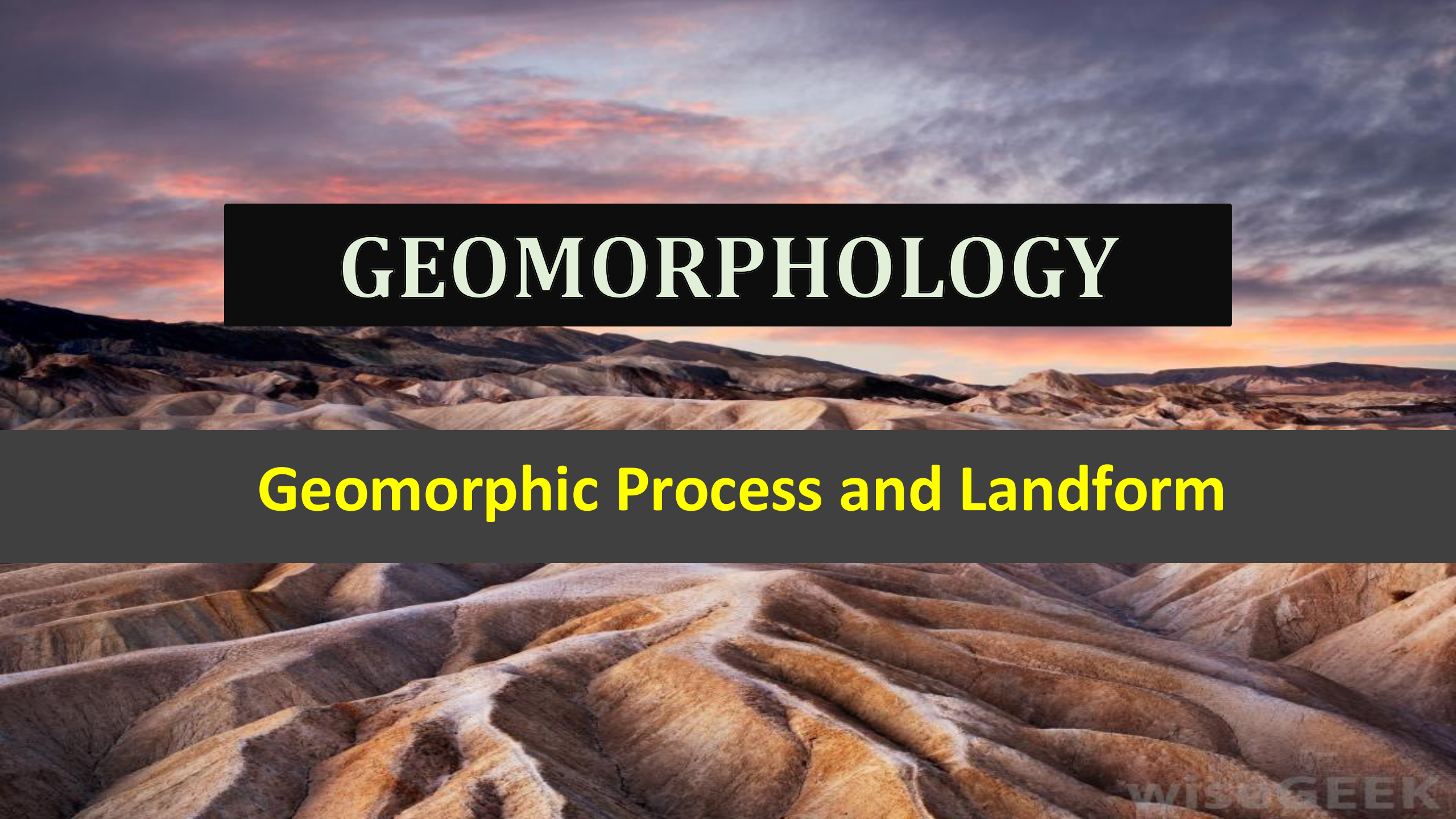
- **Feldspar:** Half the crust is composed of feldspar. It has a light colour, and its main constituents are silicon, oxygen, sodium, potassium, calcium, aluminium. It is used for **ceramics and glass making**.
- **Quartz:** It has two elements, silicon and oxygen. It has a hexagonal crystalline structure. It is uncleaved, white or colourless. It cracks like glass and is present in sand and granite. It is used in the manufacture of **radio and radar**.
- **Bauxite:** A hydrous oxide of aluminium, it is the **ore of aluminium**. It is non-crystalline and occurs in small pellets.
- **Cinnabar (mercury sulphide):** Mercury is derived from it. It has a brownish colour.
- **Dolomite:** A double carbonate of calcium and magnesium. It is used in cement and iron and steel industries. It is white.
- **Gypsum:** It is hydrous calcium sulphate and is used in cement, fertiliser and chemical industries.
- **Haematite:** It is a red ore of iron.

Rock-Forming Minerals

- . **Magnetite:** It is the black ore (or iron oxide) of iron.
- . **Amphibole:** It forms about 7 per cent of the earth's crust and consists mainly of aluminium, calcium, silica, iron, magnesium, etc. It is used in the **asbestos industry**.
- . **Mica:** It consists of potassium, aluminium, magnesium, iron, silica, etc., and forms 4 % of the earth's crust. It is generally found in igneous and metamorphic rocks and is mainly used in **electrical instruments**.
- . **Olivine:** The main elements of olivine are magnesium, iron and silica. It is normally a greenish crystal.
- . **Pyroxene:** It consists of calcium, aluminium, magnesium, iron and silica. It is of green or black colour.
- . Other minerals like chlorite, calcite, magnetite, hematite, bauxite, barite, etc., are also present in rocks.

ROCK CYCLE

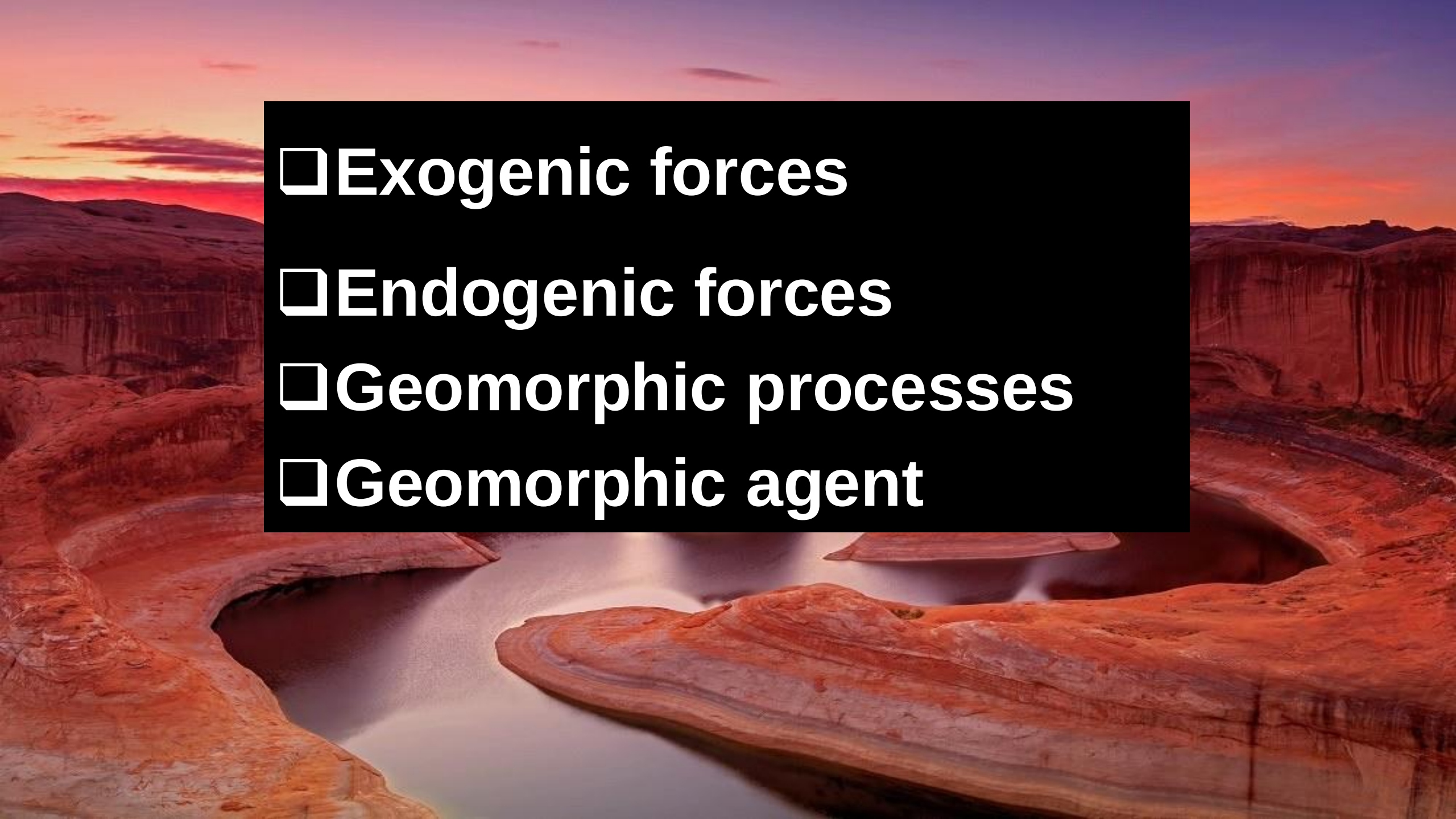


The background image shows a vast landscape of eroded, colorful hills, likely in the Valley of the Fire National Monument. The hills are characterized by distinct horizontal layers of sandstone in shades of red, orange, and tan. The sky above is filled with soft, wispy clouds, tinged with the warm colors of a sunset or sunrise, transitioning from deep orange near the horizon to a pale blue at the top. A black rectangular box is superimposed over the upper portion of the image, containing the word "GEOMORPHOLOGY" in white, serif, all-caps font.

GEOMORPHOLOGY

A close-up photograph of the eroded hills, showing the intricate patterns and textures of the sandstone. The layers are clearly visible, and the colors range from light tan to deep red. The erosion has created a series of ridges and valleys, giving the landscape a complex, sculpted appearance. A dark gray rectangular box is superimposed over the middle portion of the image, containing the text "Geomorphic Process and Landform" in yellow, sans-serif font.

Geomorphic Process and Landform

- 
- ❑ Exogenic forces
 - ❑ Endogenic forces
 - ❑ Geomorphic processes
 - ❑ Geomorphic agent

DENUDATATIONAL PROCESSES

PROCESSES

WEATHERING

MASS MOVEMENT

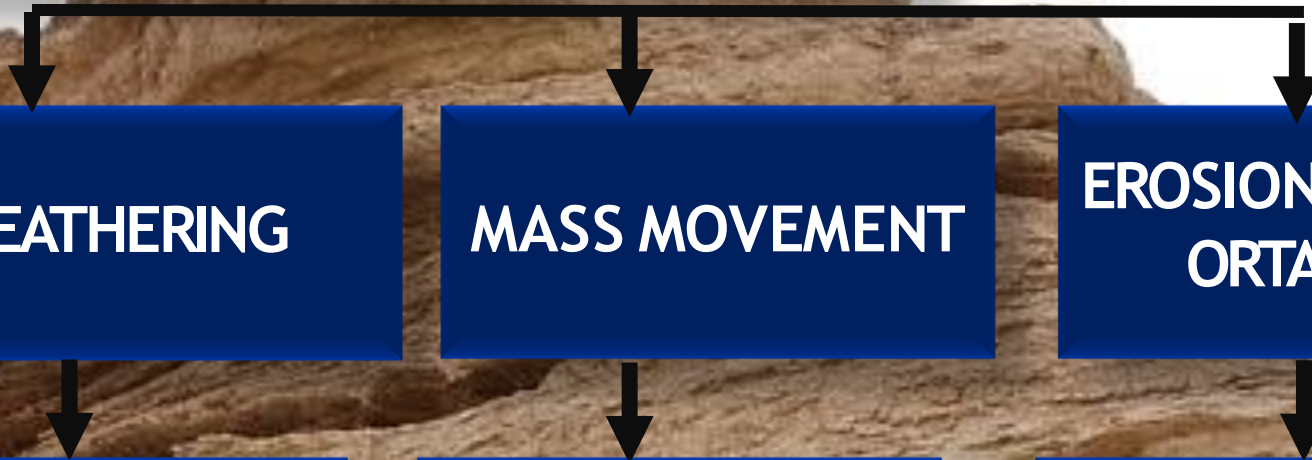
EROSION/TRANSP
ORTATION

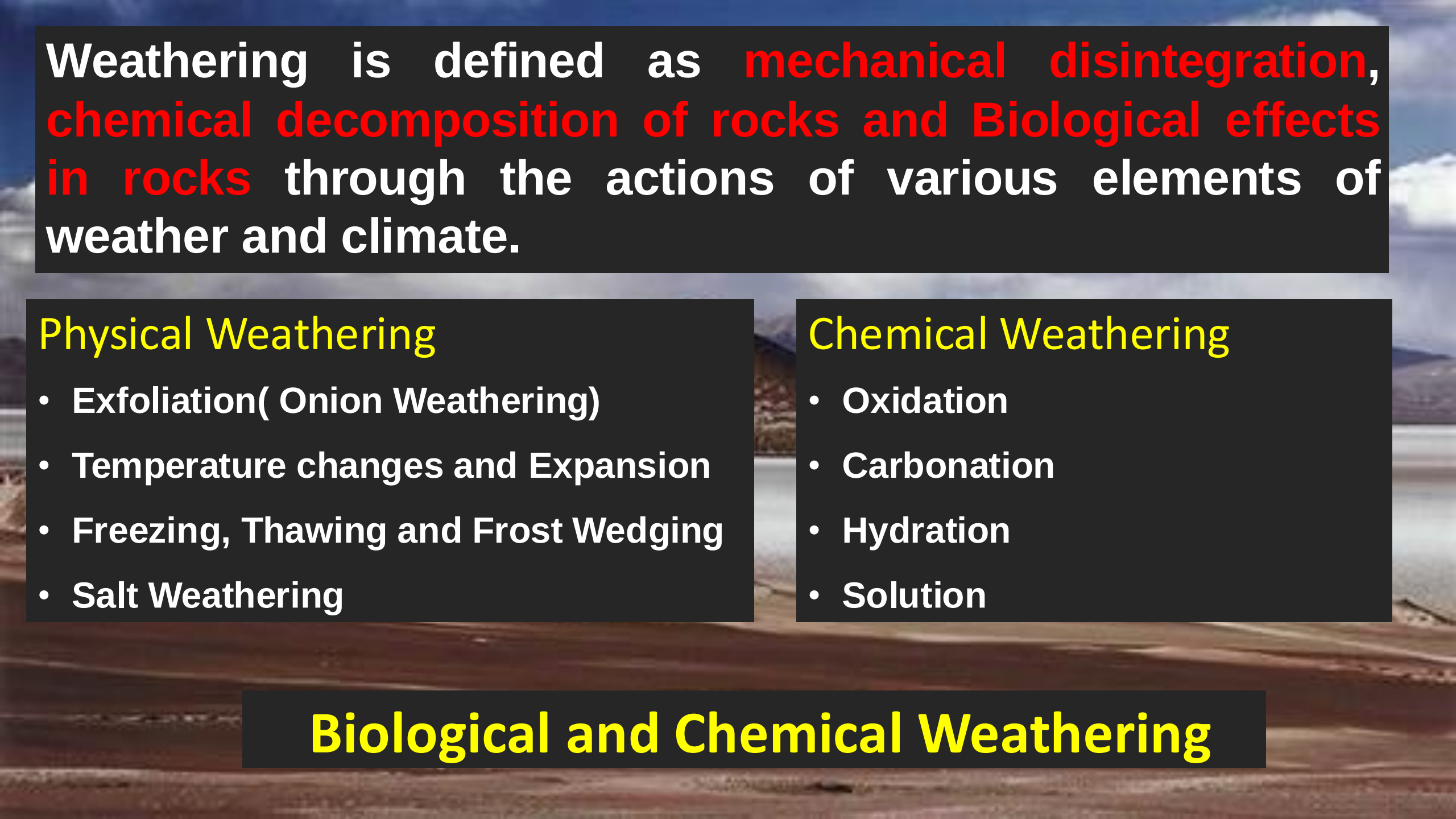
DRIVING
FORCE/ENERGY

GRAVITATIONAL/
MOLECULAR STRESSES/
AND/OR CHEMICAL
ACTIONS

GRAVITATIONAL
FORCE

KINETIC ENERGY





Weathering is defined as **mechanical disintegration, chemical decomposition of rocks and Biological effects in rocks** through the actions of various elements of weather and climate.

Physical Weathering

- Exfoliation(Onion Weathering)
- Temperature changes and Expansion
- Freezing, Thawing and Frost Wedging
- Salt Weathering

Chemical Weathering

- Oxidation
- Carbonation
- Hydration
- Solution

Biological and Chemical Weathering

Exfoliation. :

- Continued erosion causes vertical pressure
- Upper layers of the rock expand and fracture parallel to the surface
- Exfoliation due to pressure release is also known as “sheeting”.



Temperature:

- The subsequent expansion and contraction of rocks causes Thermal stress weathering
- Most effective in **dry climates** and **high elevations**



Frost weathering:

- These processes include **frost shattering**, **frost-wedging** and **freeze-thaw weathering**.

Chemical Weathering

- Acids produced by microbial and plant-root metabolism, water and air (oxygen and carbon dioxide) along with heat speed up all chemical reactions.

Natural dissolution

- Nitrates, sulphates, and potassium, oxidation potential (iron-rich minerals) will weather through dissolution naturally (rains).

Solution weathering

- When the solvent is an acidic solution
- Higher concentration of hydrogen ions than water turns into Acidic solution
- Lower concentration of hydrogen ions than water is called basic or alkaline solutions.

Carbonation

Carbonic acid reacts with limestone, it produces calcium bicarbonate, which is partially soluble in water (dissolution weathering).

Colder water holds more dissolved carbon dioxide gas. Carbonation is, therefore, a large feature of glacial weathering.

Acid rain occurs when gases such as sulphur dioxide and nitrogen oxides are present in the atmosphere.

Hydration

Chemical addition of water

Continued repetition of this process causes fatigue in the rocks and may lead to their disintegration.

➤ MASS MOVEMENTS

SLOW MOVEMENT

- ☐ Creep

- ☐ Solifluction

❖ Rapid Movements

- ☐ Landslides

- ☐ Earth Flow

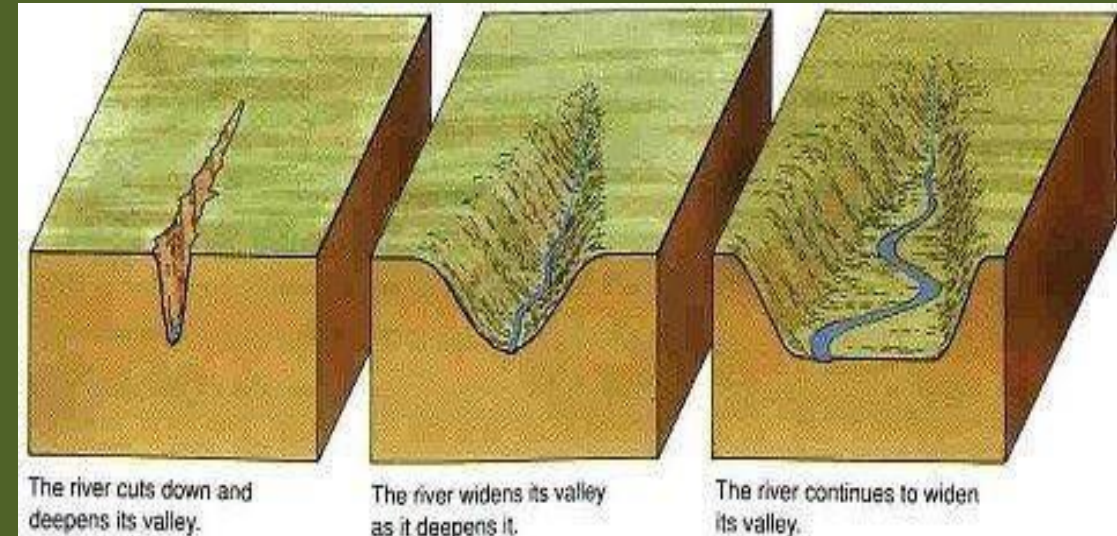
- ☐ Mud Flow

- ☐ Snow / Debris Avalanche

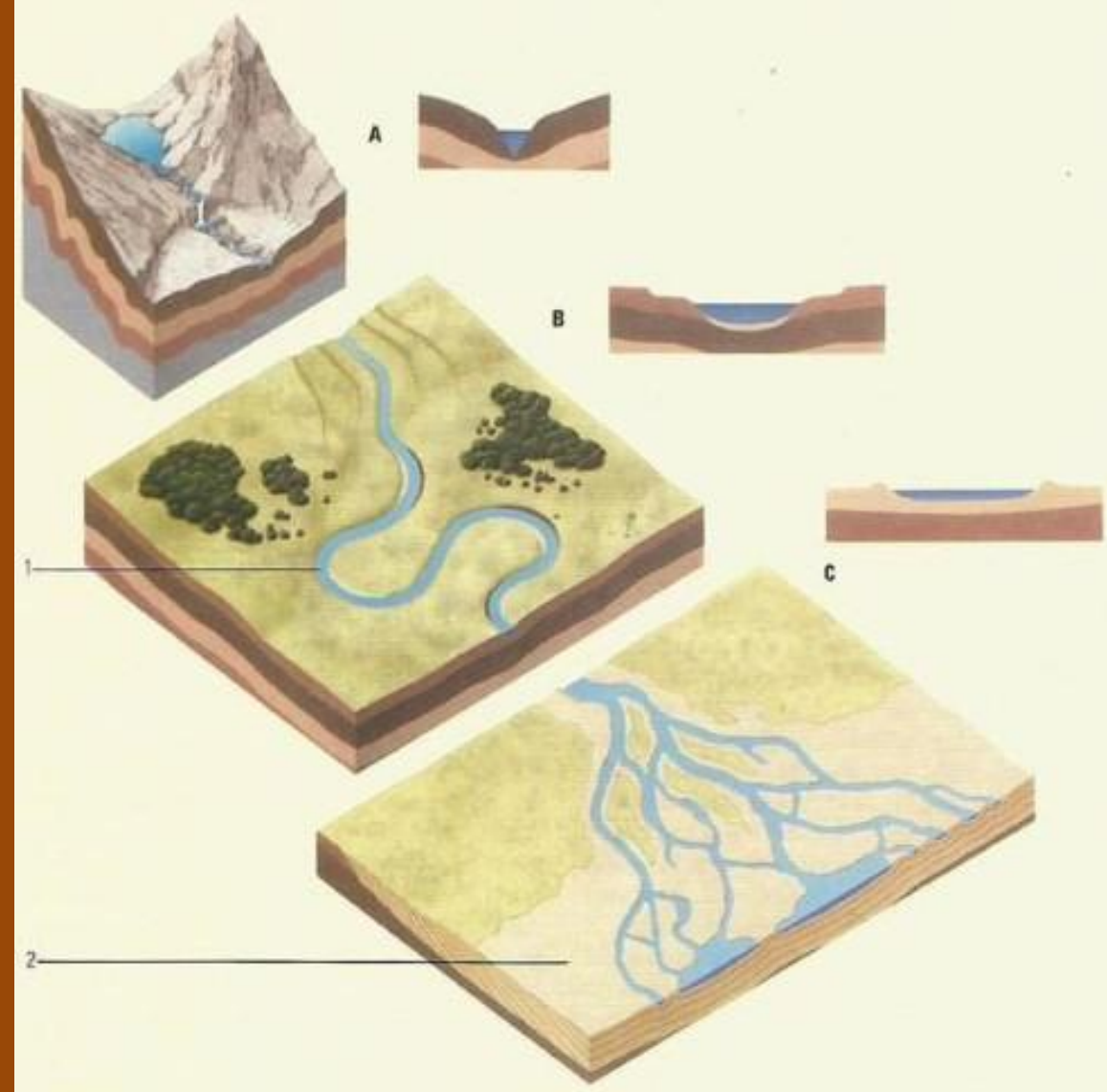


- **Youth**

- **Also known as river 's source**
- **High Velocity**
- **Flows with high erosion**
- **located high up in the mountains, forests, etc, in landscapes at very high elevation**
- **Formation of V shape valley**
- **A deep and narrow 'V' shaped valley is also referred to as gorge**
- **An extended form of the gorge is called a canyon.**

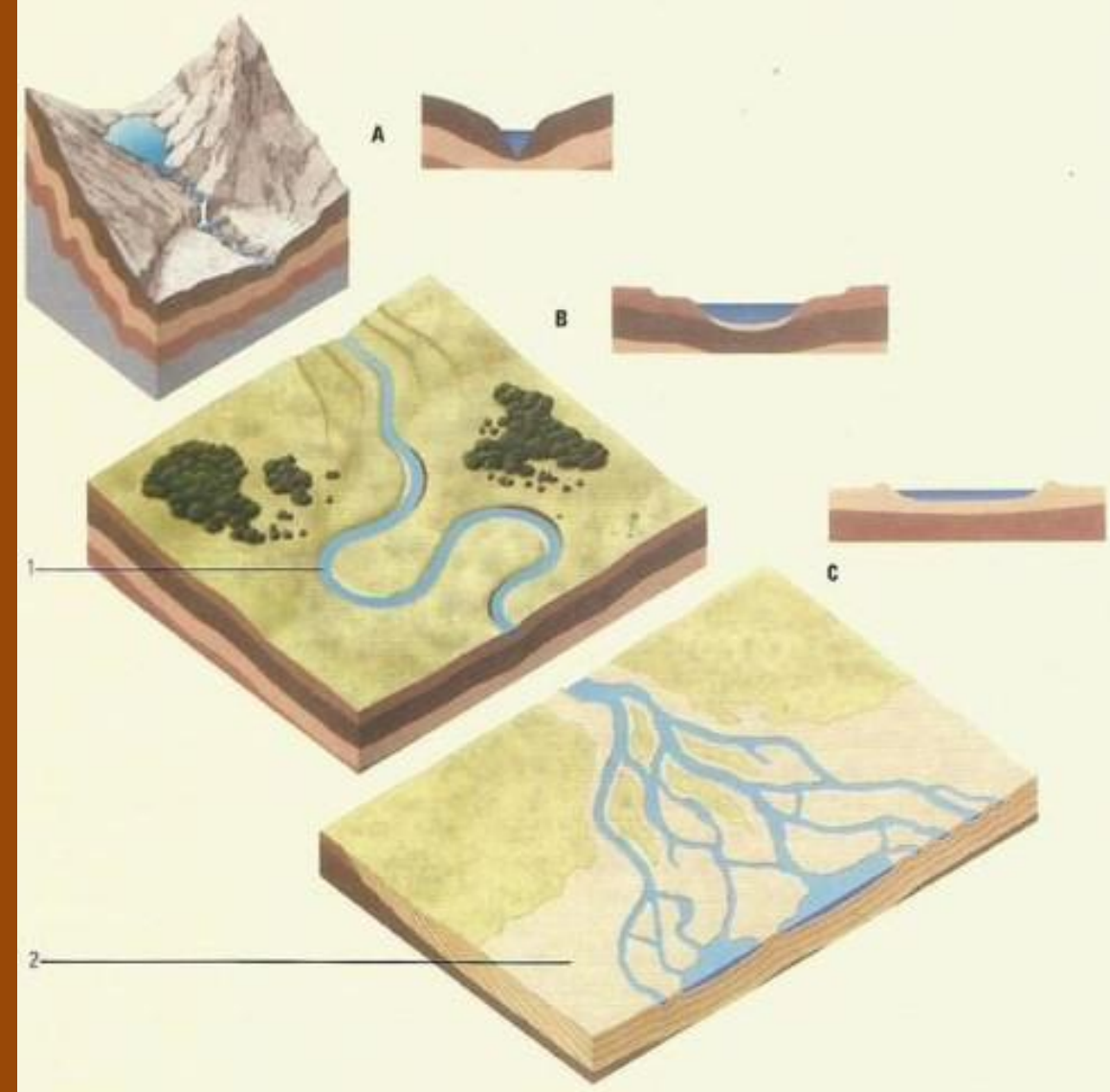


- **Maturity**
- In the maturity of a river, erosion changes
- The river begins to erode sideways (horizontally)
- This creates meanders (bends in the river) as it moves closer to ground level
- **Decrease of Velocity**
- **Formation of U shaped Valleys**
- The outer bend is called Cliff Slope Side.
- The inner side is called the slip-off side.



- **Old Stage**

- The final Stage in the river has many meanders
- It is the slowest stage of the river, and flows at almost ground level. Here, deposition occurs
- The river lets go of its rocks and other materials (the load), which is left at the bottom of the river
- These processes of the Old river make lakes that are separate from the river



Landforms formed by Rivers

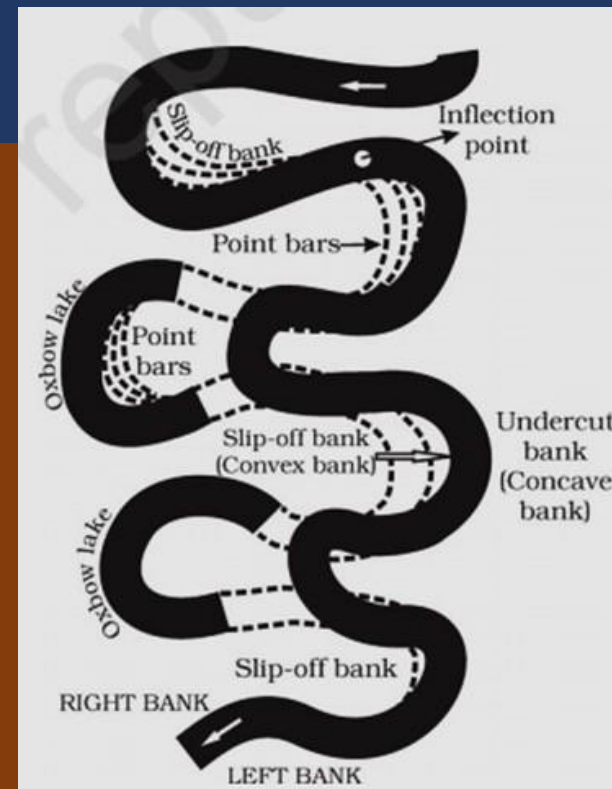
EROSIONAL LANDFORMS

- **Valleys**
- **Potholes and plunge pools**
- **Incised or entrenched meanders**
- **River terraces**



➤ Depositional Landforms

- Alluvial fans
- Deltas
- Floodplains, Natural levees and Point bars
- Meanders
- Braided channels



Drainage Basin

- Also known as **catchment**, **catchment area**, **catchment basin**, **drainage area**, **river basin**, and **water basin**.
- A funnel by collecting all the water within the area covered by the basin and channelling it to a single point.
- In **closed drainage** basins the water converges to a single point inside the basin, known as a **sink**, which may be a permanent lake (e.g. Lake Aral, also known Aral Sea, Dead Sea), dry lake (some desert lakes like Lake Chad, Africa), or a point where surface water is lost underground.

Difference between a River Basin and a Watershed:

- Both river basins and watersheds are areas of land that drain to a particular water body, such as a lake, stream, river or estuary.
- In a river basin, all the water drains to a large river. The term watershed is used to describe a smaller area of land that drains to a smaller stream, lake or wetland.
- There are many smaller watersheds within a river basin.

Example: watershed of Yamuna + watershed of Chambal + watershed of Gandak + = Drainage basin of Ganga.

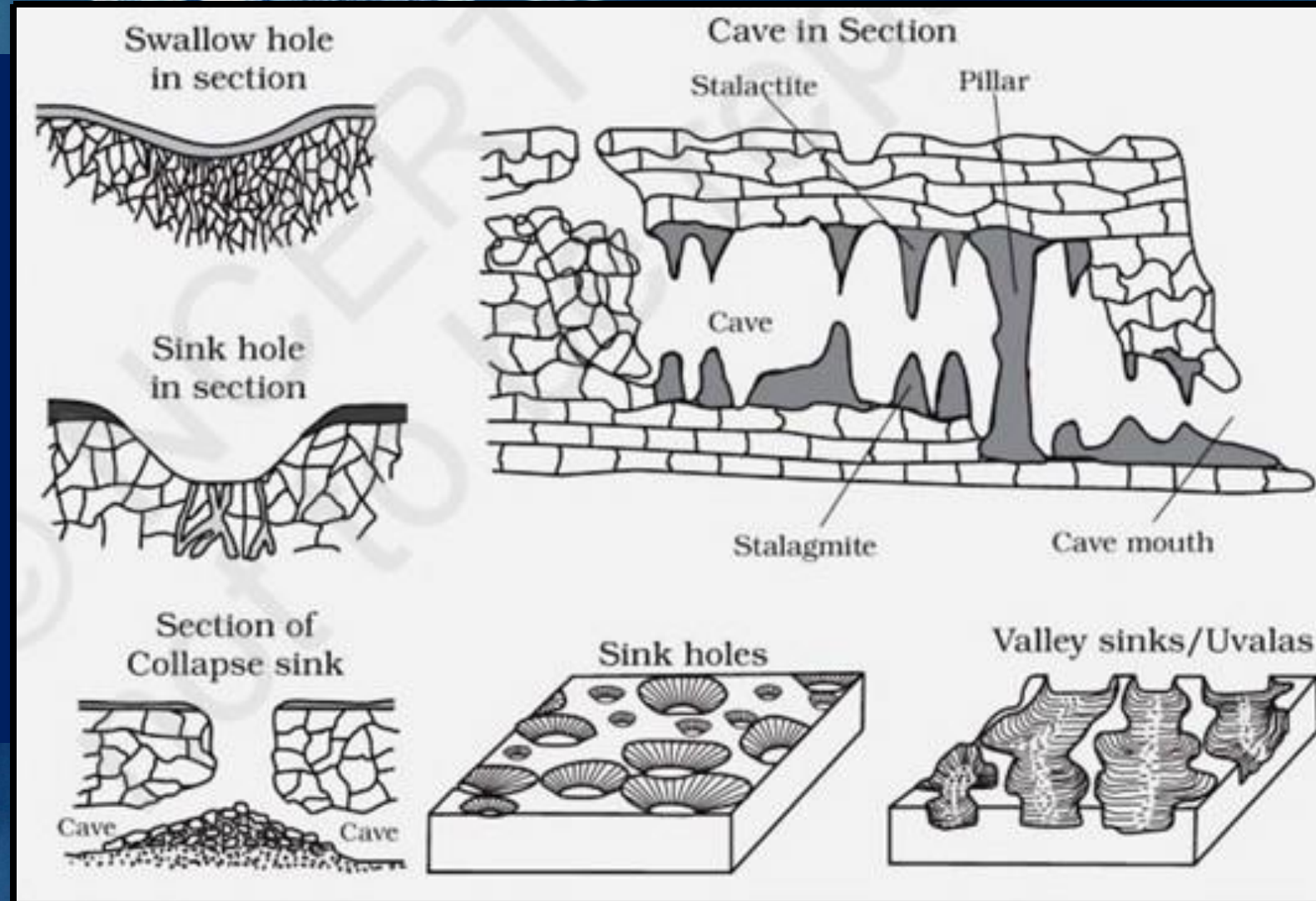
LANDFORMS FORMED BY GROUNDWATER

➤ EROSIONAL LANDFORMS

- Pools, Sinkholes, Lapis and Limestone pavements
- Caves

➤ DEPOSITIONAL LANDFORMS

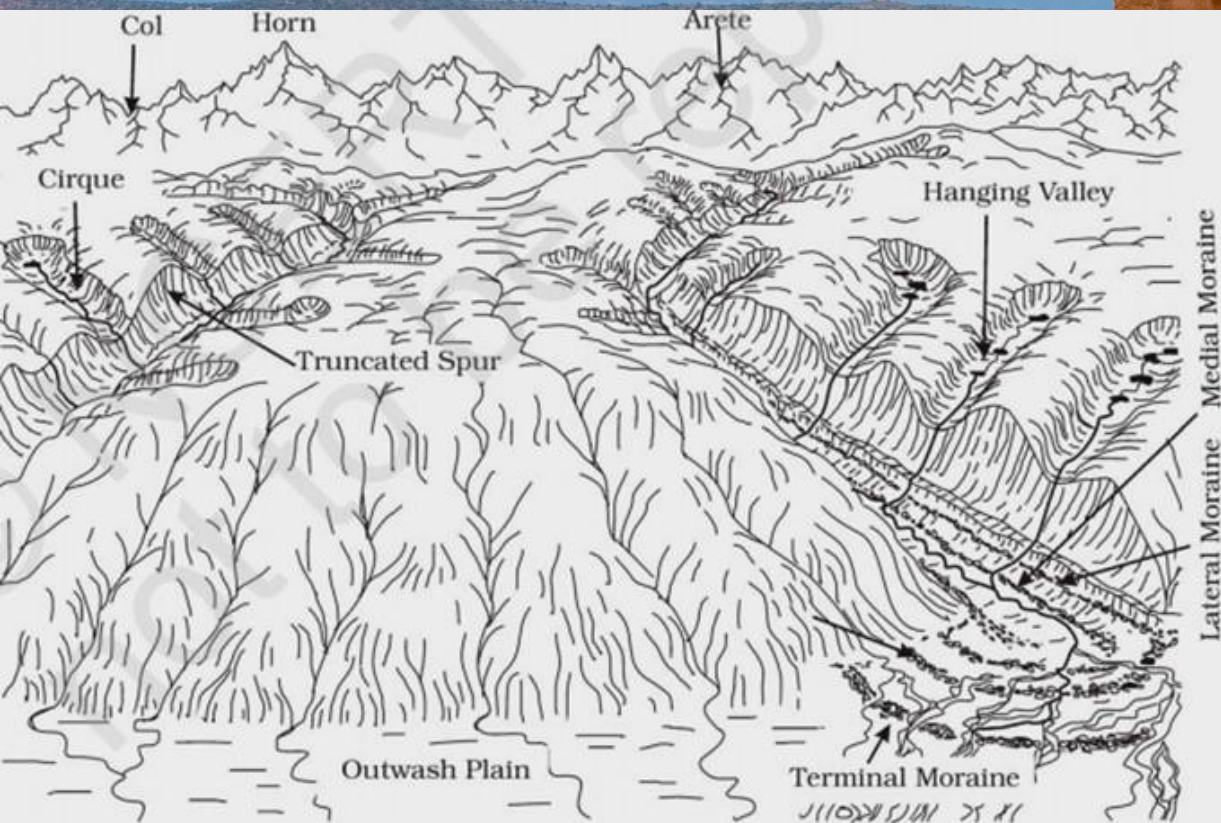
- Stalactites, stalagmites and pillars



GLACIERS

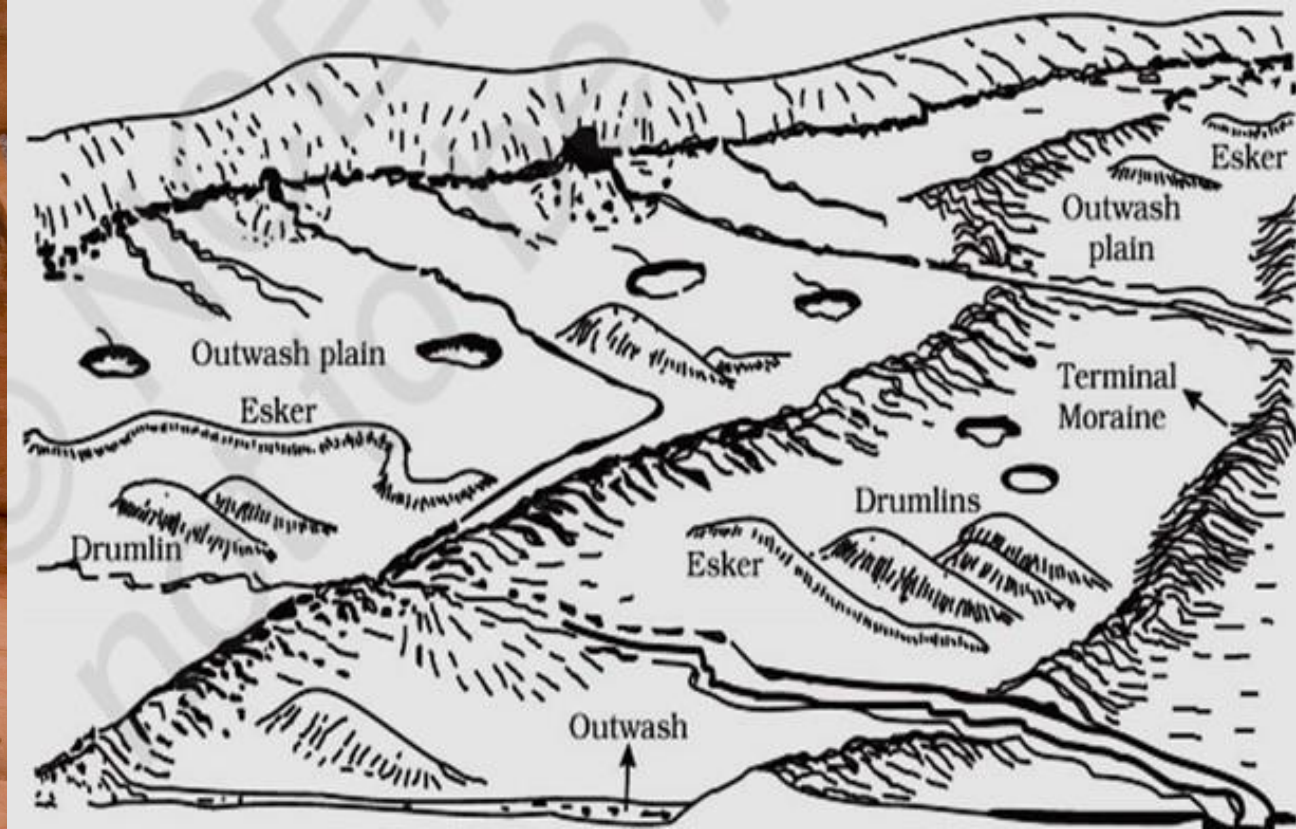
➤ EROSIONAL LANDFORMS

- Cirque
- Horns and serrated ridges
- Glacial valleys / troughs



➤ DEPOSITIONAL LANDFORMS

- Moraines
- Eskers
- Outwash plains
- Drumlins



Cirque/Corrie:

- Hollow basin cut into a mountain ridge.
- It has steep sided slope on three sides, an open end on one side and a flat bottom.
- When the ice melts, the cirque may develop into a **tarn lake**.

Glacial Trough:

- Original stream-cut valley, further modified by glacial action.
- It is a 'U' Shaped Valley. It at mature stage of valley formation.
- Since glacial mass is heavy and slow moving, erosional activity is uniform – horizontally as well as vertically.
- A steep sided and flat bottomed valley results, which has a 'U' shaped profile.

Hanging Valley:

- Formed when smaller tributaries are unable to cut as deeply as bigger ones and remain 'hanging' at higher levels than the main valley as discordant tributaries.
- A valley carved out by a small tributary glacier that joins with a valley carved out by a much larger glacier.

Arete:

- Steep-sided, sharp-tipped summit with the glacial activity cutting into it from two

Horn:

- Ridge that acquires a 'horn' shape when the glacial activity cuts it from more than two sides.

Glacial Depositional Landforms

Outwash Plain

When the glacier reaches its lowest point and melts, it leaves behind a stratified deposition material, consisting of rock debris, clay, sand, gravel etc. This layered surface is called till plain or an outwash plain.

Esker

Winding ridge of un-assorted depositions of rock, gravel, clay etc. running along a glacier in a till plain.

The eskers resemble the features of an embankment and are often used for making roads.

Glacial Depositional Landforms

Kame Terraces

Broken ridges or un-assorted depositions looking like hump in a till plain.

Drumlin

Inverted boat-shaped deposition in a till plain caused by deposition.

Kettle Holes

Formed when the deposited material in a till plain gets depressed locally and forms a basin.

Moraine

General term applied to rock fragments, gravel, sand, etc. carried by a glacier. Depending on its position, the moraine can be ground moraine and end moraine.

WAVES AND CURRENTS

➤ EROSIONAL LANDFORMS

- Cliffs, terraces, caves

➤ DEPOSITIONAL LANDFORMS

- Beaches and dunes
- Bars, barriers



WINDS

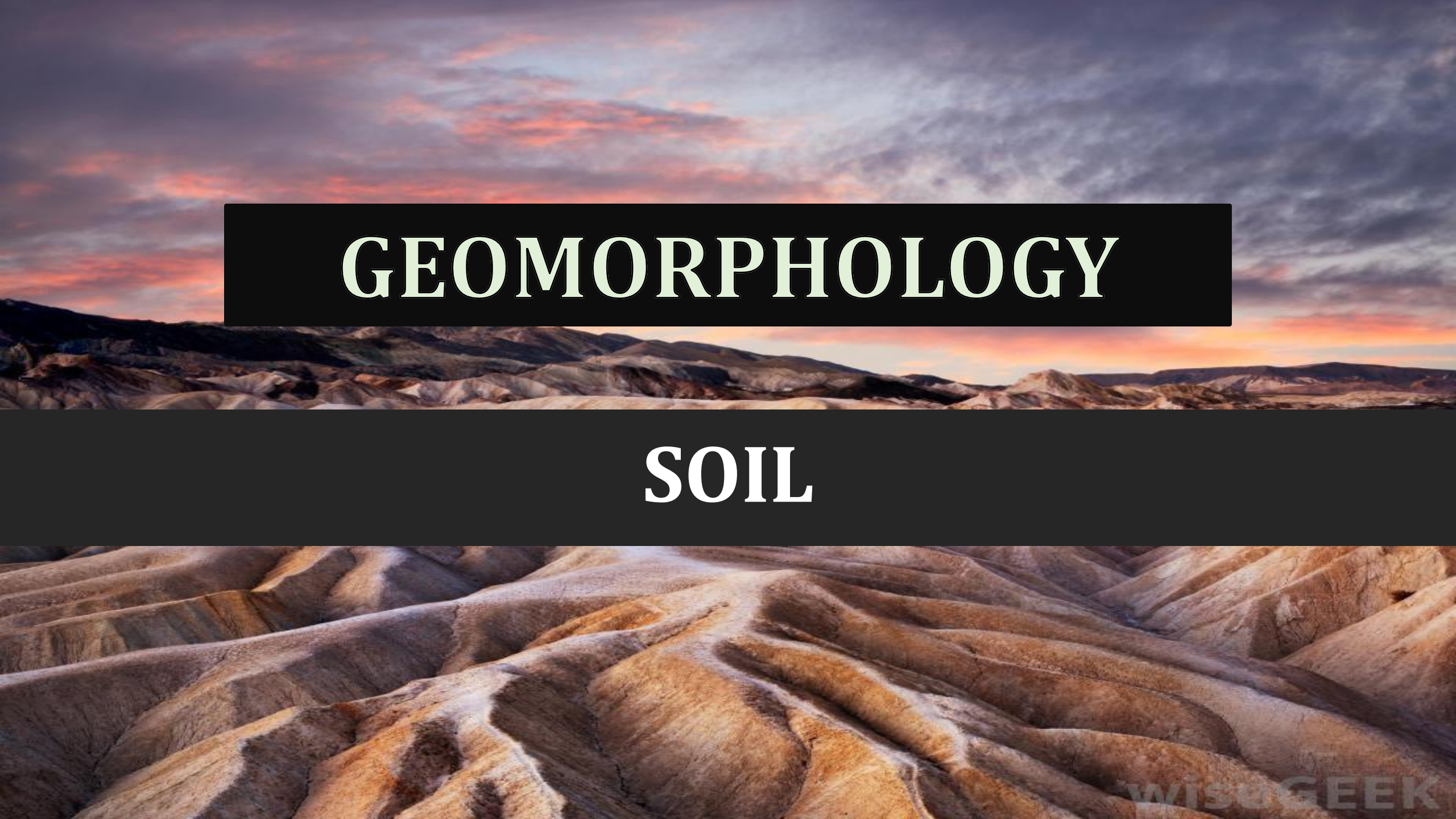
➤ EROSIONAL LANDFORMS

- Pediments and pediplains
- Plays
- Deflation hollows and caves
- Mushroom table and pedestal rocks

➤ DEPOSITIONAL LANDFORMS

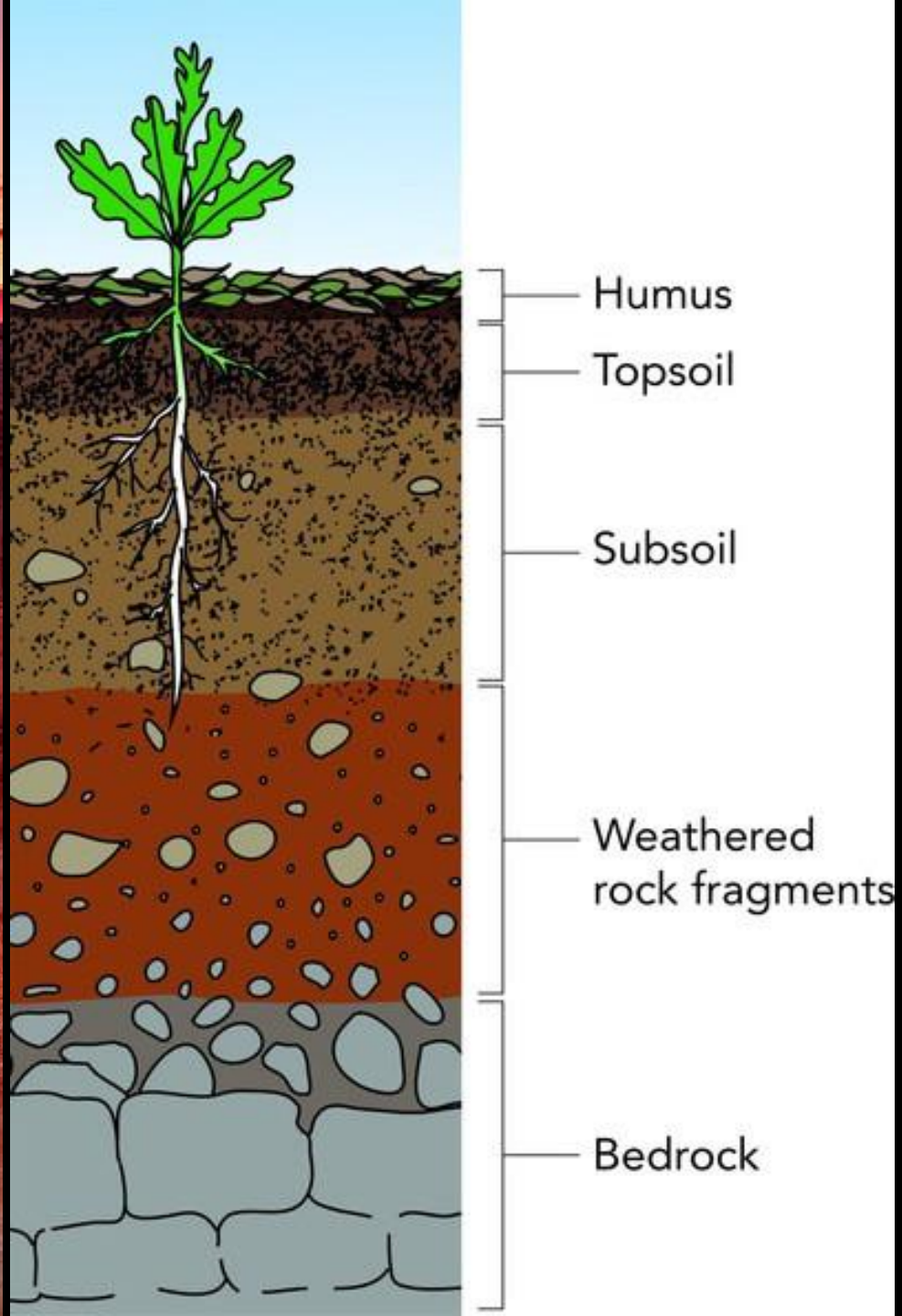
- Sand dunes



The background image shows a vast landscape of badlands, characterized by deep, winding erosion channels and layered rock formations. The sky above is filled with soft, colorful clouds in shades of orange, pink, and purple, suggesting a sunset or sunrise. The overall scene is desolate and dramatic.

GEOMORPHOLOGY

SOIL



SOIL PROFILE

Pedology is the study

Pedogenesis is the natural process of soil formation



O Horizon/Humus

- Layers mainly dominated by organic material.
- decomposed litter such as leaves, needles, twigs, moss, and lichens

A Horizon or Surface soil

- Here, organic matter is mixed with mineral matter.
- This layer is depleted of (eluviated of) iron, clay, aluminum, organic compounds, and other soluble constituents.
- Due to depletion of the above materials this layer has a lighter coloured texture

E horizon

- 'E' stands for eluviated layer.
- Leaching of clay, iron, and aluminum oxides that leaves a concentration of resistant minerals (quartz, in the sand and silt sizes)
- Present in older, well-developed soils
- Occur between the A and B horizons



- **B Horizon or Subsoil**
Chemical or physical alteration of parent material.
Accumulates all the leached minerals from A and E horizon.
Iron, Clay, Aluminium and organic compounds accumulate in this horizon

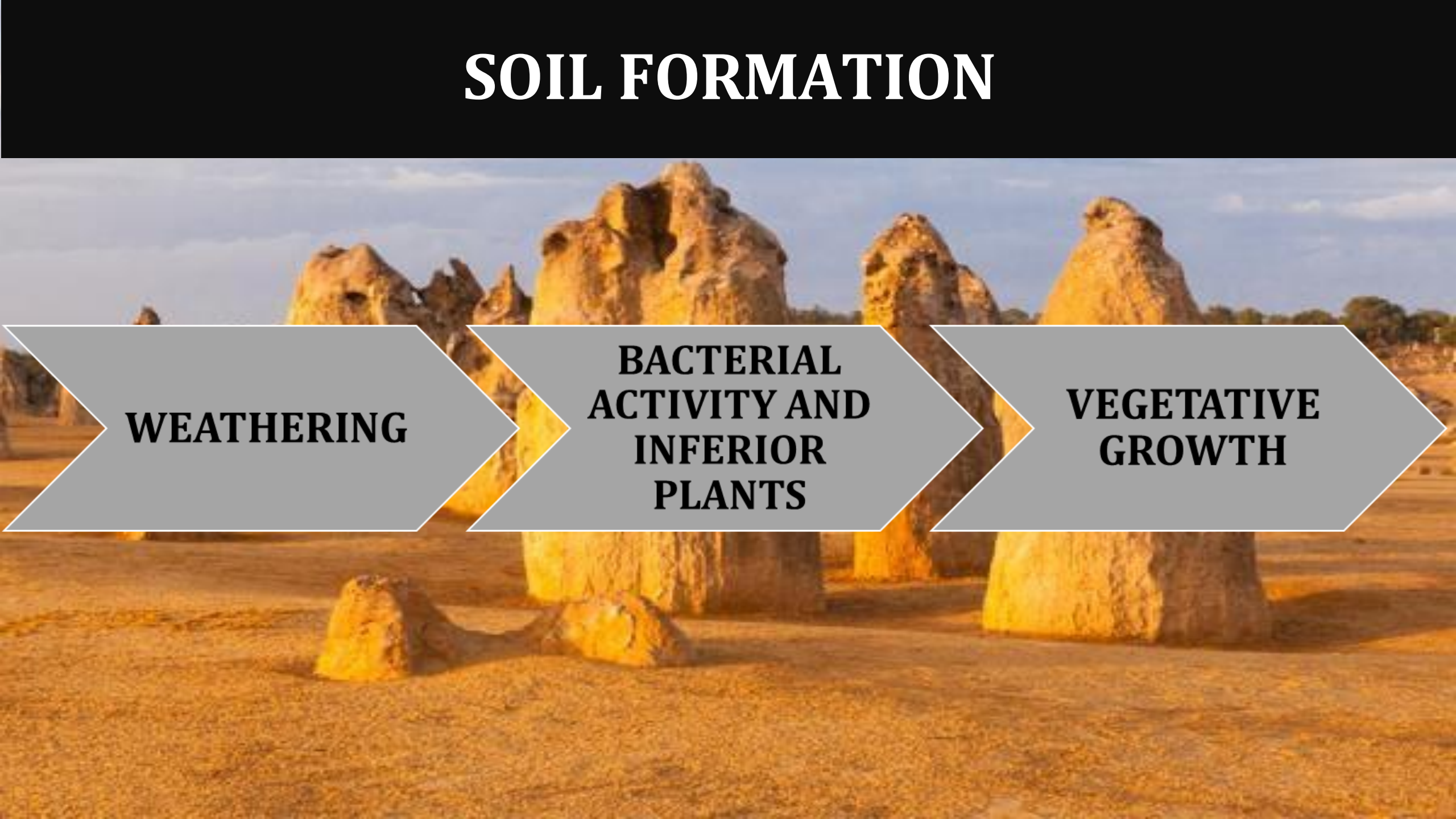
C Horizon or Parent rock

- Weathered parent material accumulates in this layer
- Layer of large unbroken rocks.
- This layer may accumulate the more soluble compounds (inorganic material).

R Horizon or Bedrock

- Partially weathered bedrock at the base of the soil profile.
- R horizons largely comprise continuous masses of hard rock.

SOIL FORMATION



The diagram illustrates the three stages of soil formation: WEATHERING, BACTERIAL ACTIVITY AND INFERIOR PLANTS, and VEGETATIVE GROWTH. These stages are represented by three overlapping chevron shapes pointing from left to right, set against a background of a desert landscape with large, weathered rock formations (hoodoos) under a clear sky.

WEATHERING

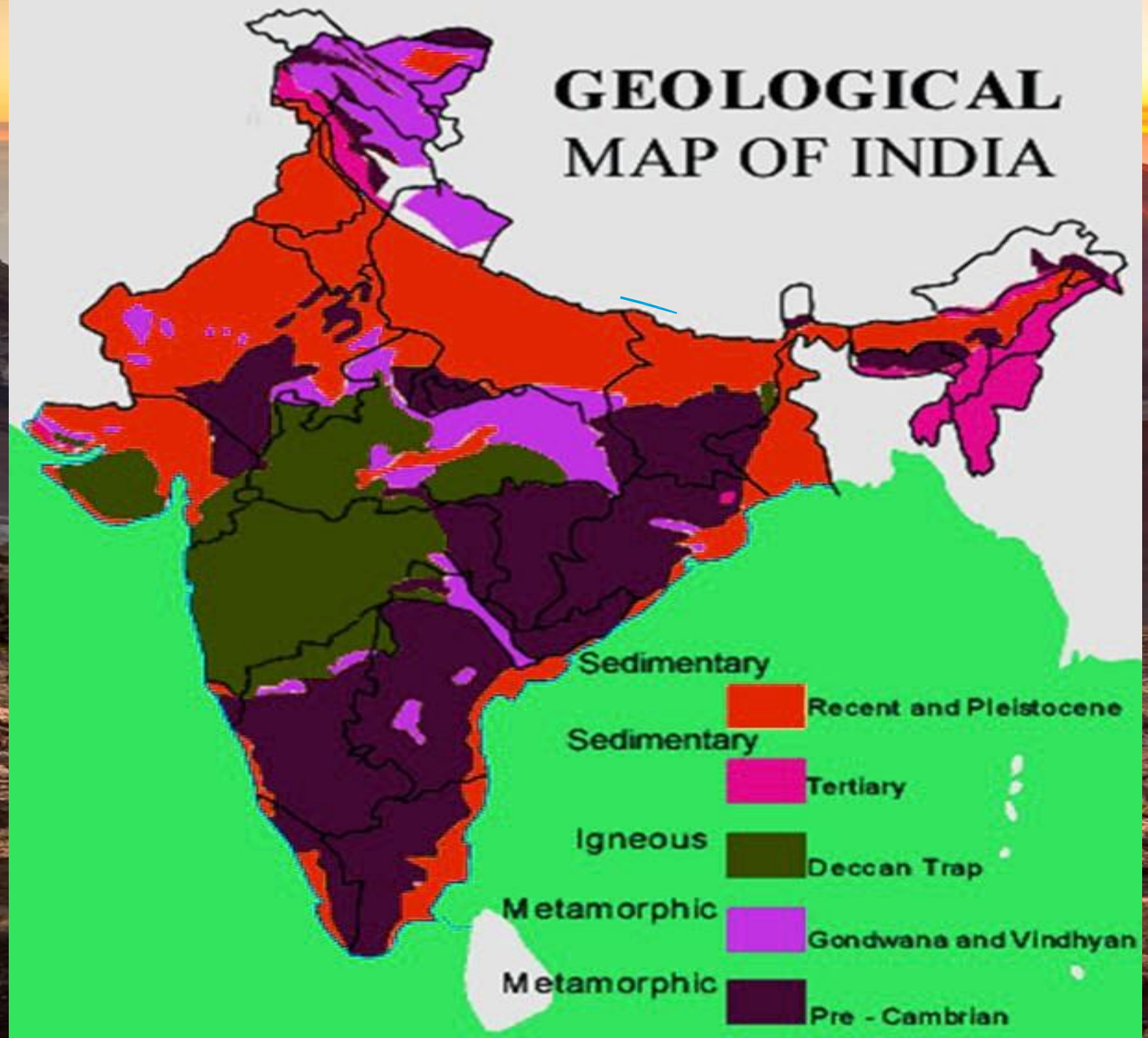
**BACTERIAL
ACTIVITY AND
INFERIOR
PLANTS**

**VEGETATIVE
GROWTH**

FACTORS

- **PARENT MATERIAL**
- **TOPOGRAPHY**
- **CLIMATE**
- **BIOLOGICAL ACTIVITY**
- **TIME**

ROCK TYPES



- Around 40 % of total land area
- Soil vary in nature from sandy loam to clay
- Rich in potash but poor in phosphorous
- Khadar(young)and Bhangar(old) soils contain calcareous/ calcium carbonate concretions (Kankars)
- Colour of the alluvial soils varies from the light grey to ash grey

ALLUVIAL SOIL



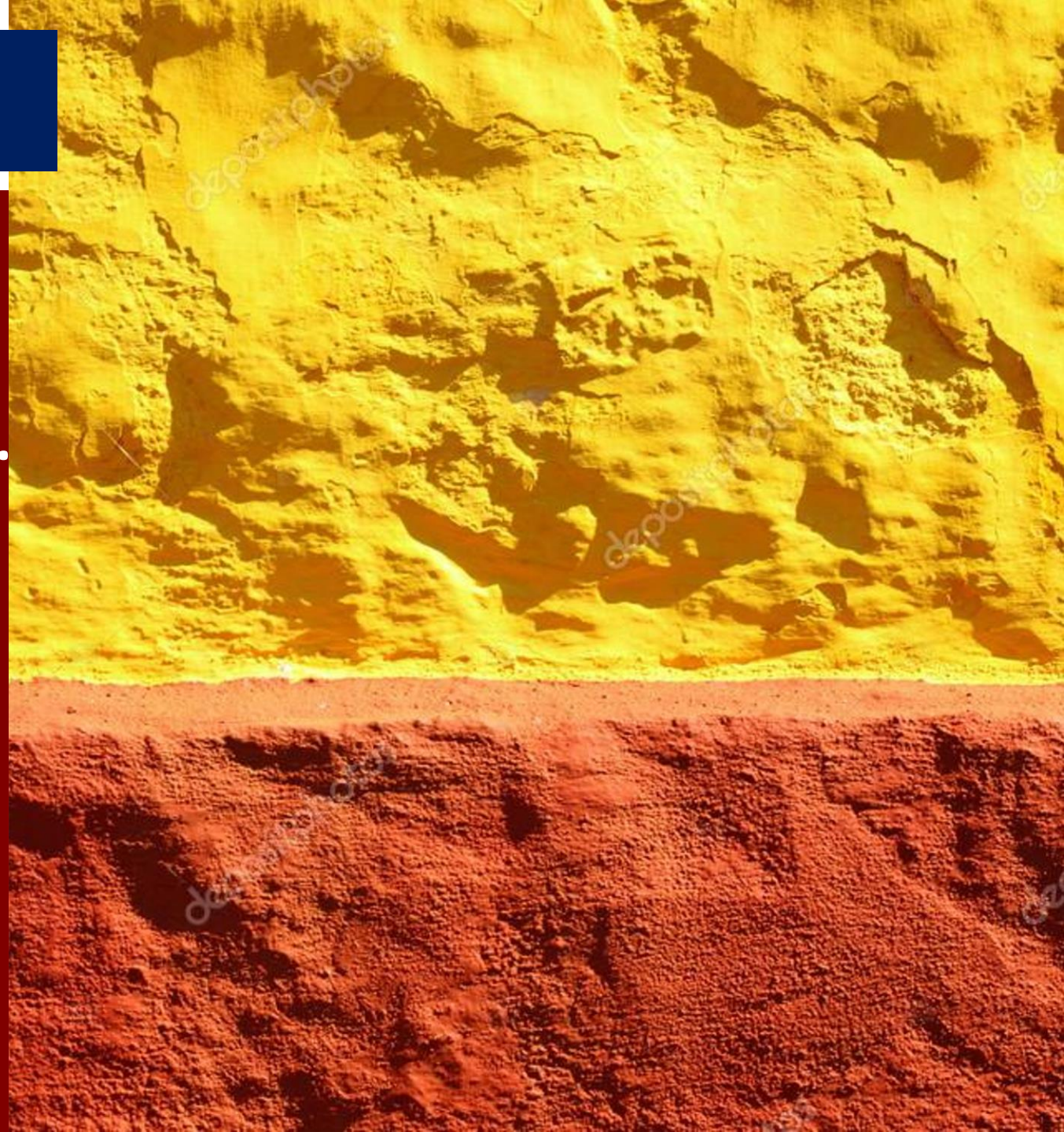


BLACK SOIL

- Black soil is very deep.
- 'Regur Soil' or the 'Black Cotton Soil'
- Generally clayey, deep and impermeable.
- Self ploughing - They swell and become sticky when wet and shrink when dried.
- Rich in lime, iron, magnesia and alumina. They also contain potash.
- Lack in phosphorous, nitrogen and organic matter.
- The colour of the soil ranges from deep black to grey.

RED AND YELLOW SOIL

- The soil develops a reddish colour due to a wide diffusion of iron in crystalline and metamorphic rocks.
- It looks yellow when it occurs in a hydrated form.
- The fine-grained red and yellow soils are normally fertile, whereas coarse-grained soils found in dry upland areas are poor in fertility.
- They are generally poor in nitrogen, phosphorous and humus.



LATERITE SOIL

- The laterite soils develop in areas with high temperature and high rainfall
- Intense leaching due to tropical rains
- With rain, lime and silica are leached away, and soils rich in iron oxide and aluminium compound are left behind
- Humus content of the soil is removed fast by bacteria that thrives well in high temperature.

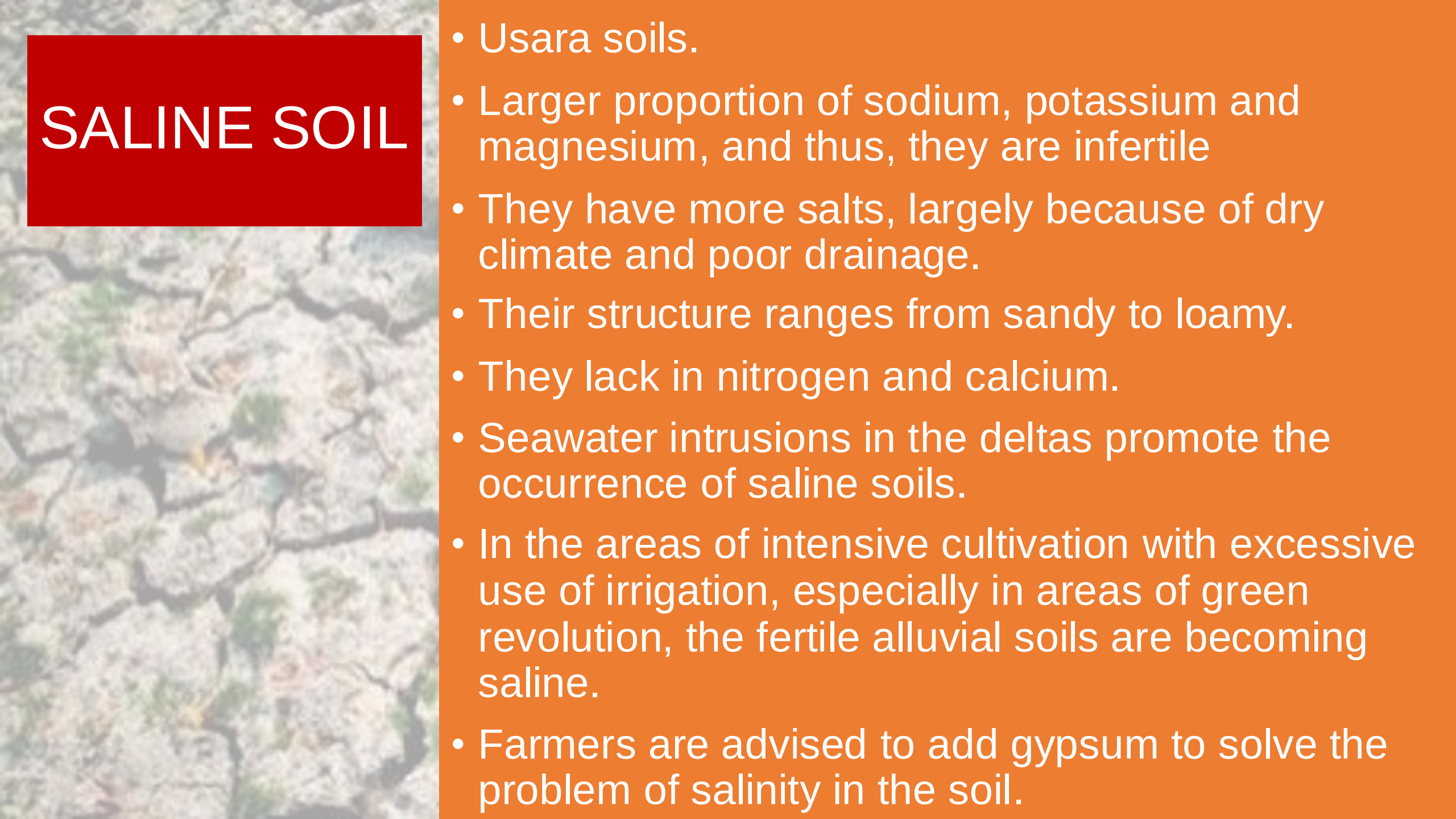
LATERITE SOIL

- Poor in organic matter, nitrogen, phosphate and calcium, while iron oxide and potash are in excess.
- Hence, laterites are not suitable for cultivation
- Red laterite soils in Tamil Nadu, Andhra Pradesh and Kerala are more suitable for tree crops like cashew nut, Tapioca
- Laterite soils are widely cut as bricks for use in house construction.

ARID SOIL

- Sandy in structure and saline in nature
- They lack moisture and humus
- Nitrogen is insufficient and the phosphate content is normal
- 'Kankar' layers





SALINE SOIL

- Usara soils.
- Larger proportion of sodium, potassium and magnesium, and thus, they are infertile
- They have more salts, largely because of dry climate and poor drainage.
- Their structure ranges from sandy to loamy.
- They lack in nitrogen and calcium.
- Seawater intrusions in the deltas promote the occurrence of saline soils.
- In the areas of intensive cultivation with excessive use of irrigation, especially in areas of green revolution, the fertile alluvial soils are becoming saline.
- Farmers are advised to add gypsum to solve the problem of salinity in the soil.

PEATY SOIL



- Areas of heavy rainfall and high humidity and high vegetation
- High organic matter content

FOREST SOIL

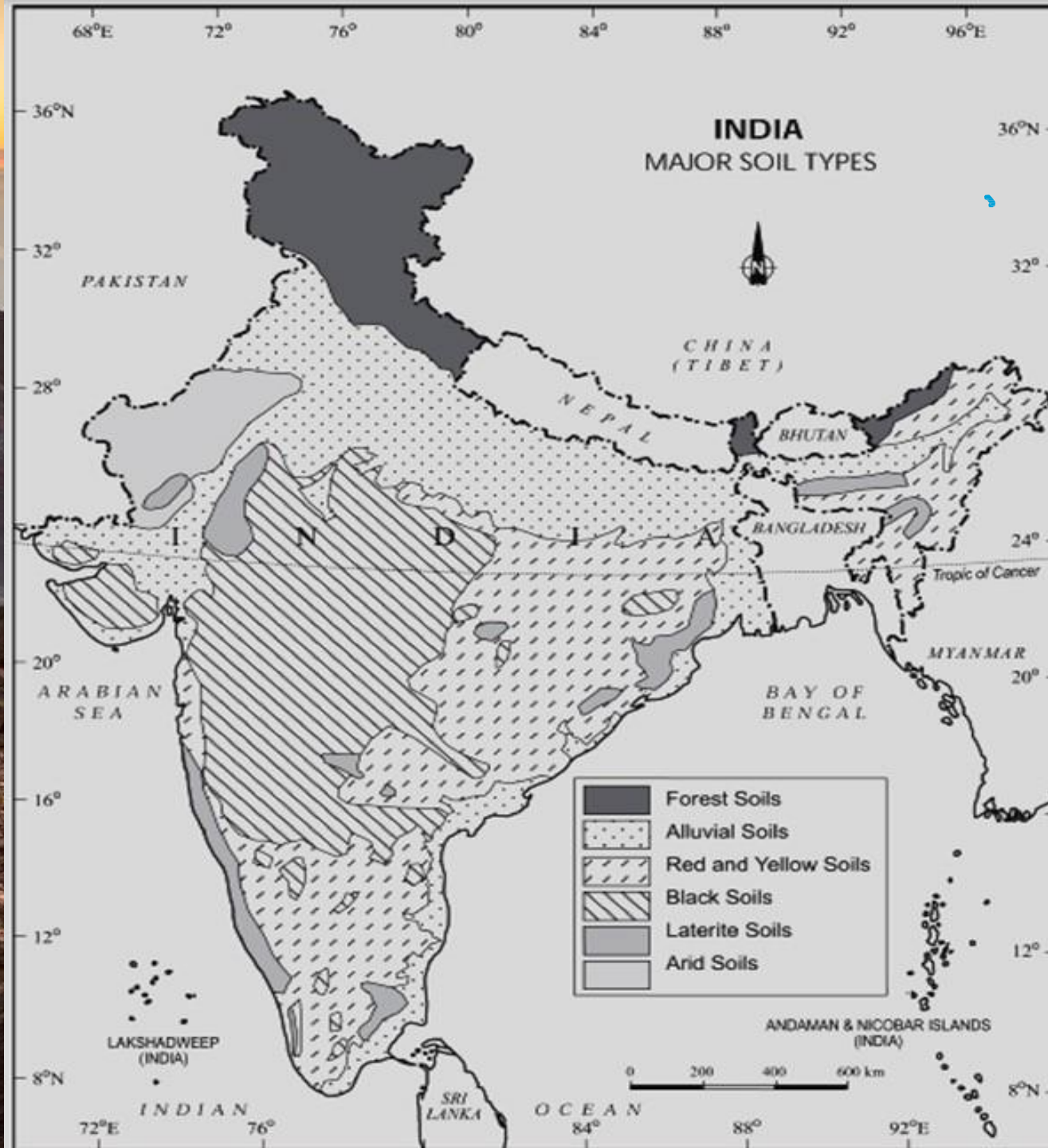
- Loamy and silty on valley sides and coarse-grained in the upper slopes.



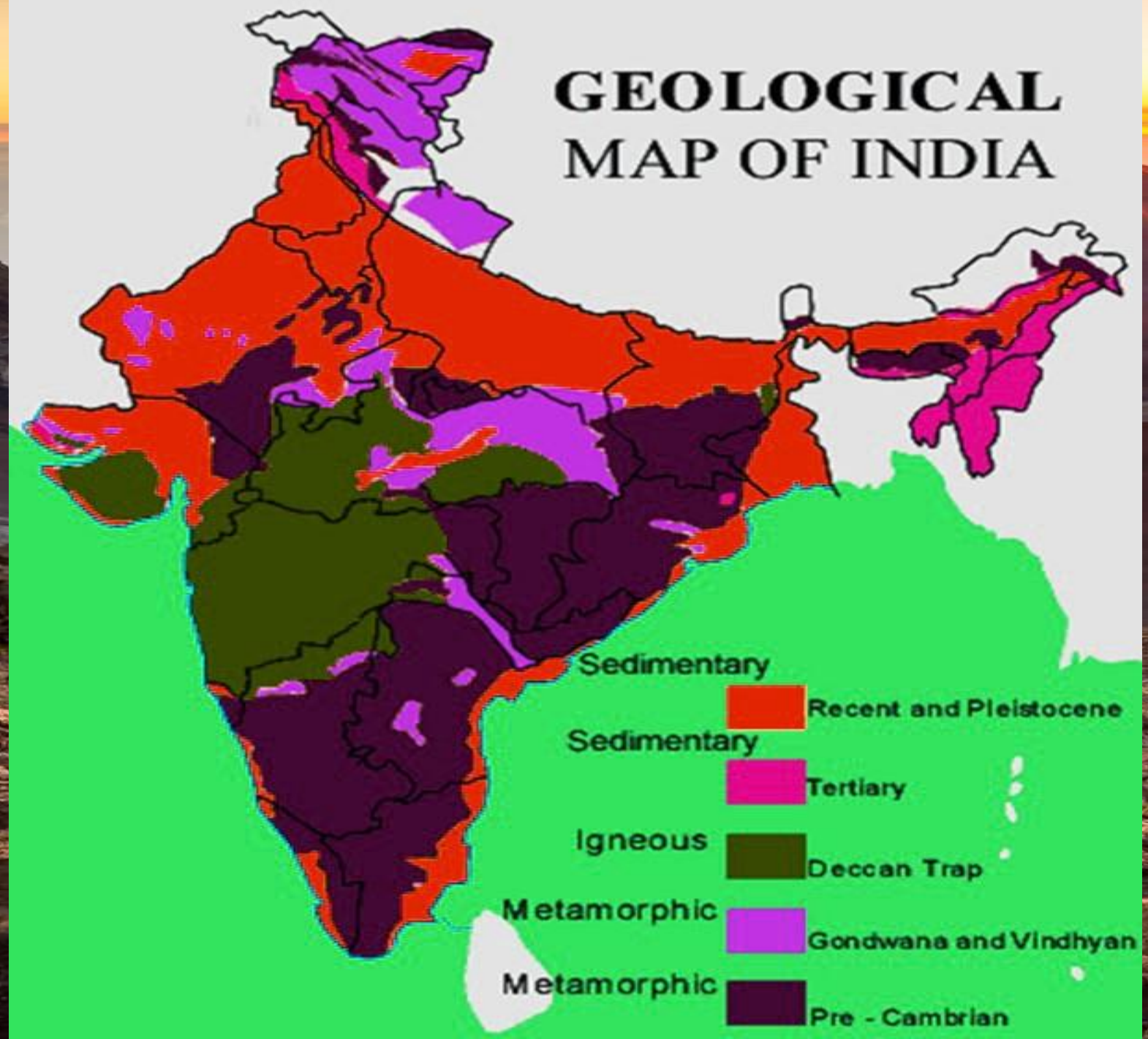
Soil Types	Properties	Nutrients	Places Found	Crops Type
ALLUVIAL SOIL	sandy loam to clay, the most fertile soil of all other soils	Potassium, Calcium carbonate, phosphoric acid and lime	The entire northern <u>plains</u> , <u>Arunachal Pradesh</u> , <u>Assam</u> , <u>Bihar</u> , eastern costal plains	Sugarcane, paddy, wheat, and other cereal and pulse crops.
BLACK SOIL	Clayey, deep and impermeable, Self ploughing	Iron, lime, calcium, potash, magnesium, and aluminium. Poor in phosphoric, nitrogen & organic matter contents	North west <u>Deccan plateau</u> , <u>Maharashtra</u> , <u>Saurashtra</u> , <u>Malwa</u> , <u>M adhya Pradesh</u> , and <u>Chattishgarh</u> and extend in the south-east direction along the <u>Godavari</u> and the <u>Krishna</u> valleys.	Cotton. Other major crops grown on the black soils include wheat, jowar, linseed, virginia tobacco, castor, sunflower and millets.
RED AND . YELLOW SOIL	Reddish colour due to diffusion of iron in crystalline and metamorphic rocks.	Non-soluble material 90.47%, iron 3.61%, aluminium 2.92%, Poor in nitrogen, phosphorous and humus.	Eastern and southern parts of the Deccan plateau, <u>Odisha</u> , <u>Chhattisgarh</u> , southern parts of the middle <u>Ganga plain</u> and along the Piedmont zone of the Western Ghats.	Rice, wheat, sugarcane, maize/corn, groundnut, ragi (finger millet) and potato, oilseeds, pulses, millets, and fruits such as mango, orange, citrus, and vegetables

LATERITE SOIL	Develops in areas with high temperature and heavy rainfall. Humus content of the soil is low	90–100% of iron, aluminium, titanium, and manganese oxides. lower content of nitrogen, phosphorus, potassium, lime, and magnesia	<u>Karnataka</u>, <u>Kerala</u>, <u>Tamil Nadu</u>, <u>Madhya Pradesh</u>, and the hilly areas of <u>Odisha</u> and Assam	Tea and coffee. More suitable for crops like cashew nut, tapioca starch.
ARID SOIL	Red and brown in colour. sandy & saline in nature and lacks humus and moisture. Soluble salts. It is alkaline in nature because there is no rain to wash soluble salts.	Calcium carbonates, gypsum, as well as sodium.	Western Rajasthan, Haryana, and Punjab and extends up to the Rann of Kutch in Gujarat	Wheat, cotton, corn (maize), millets, pulses, and barley

SOIL TYPES

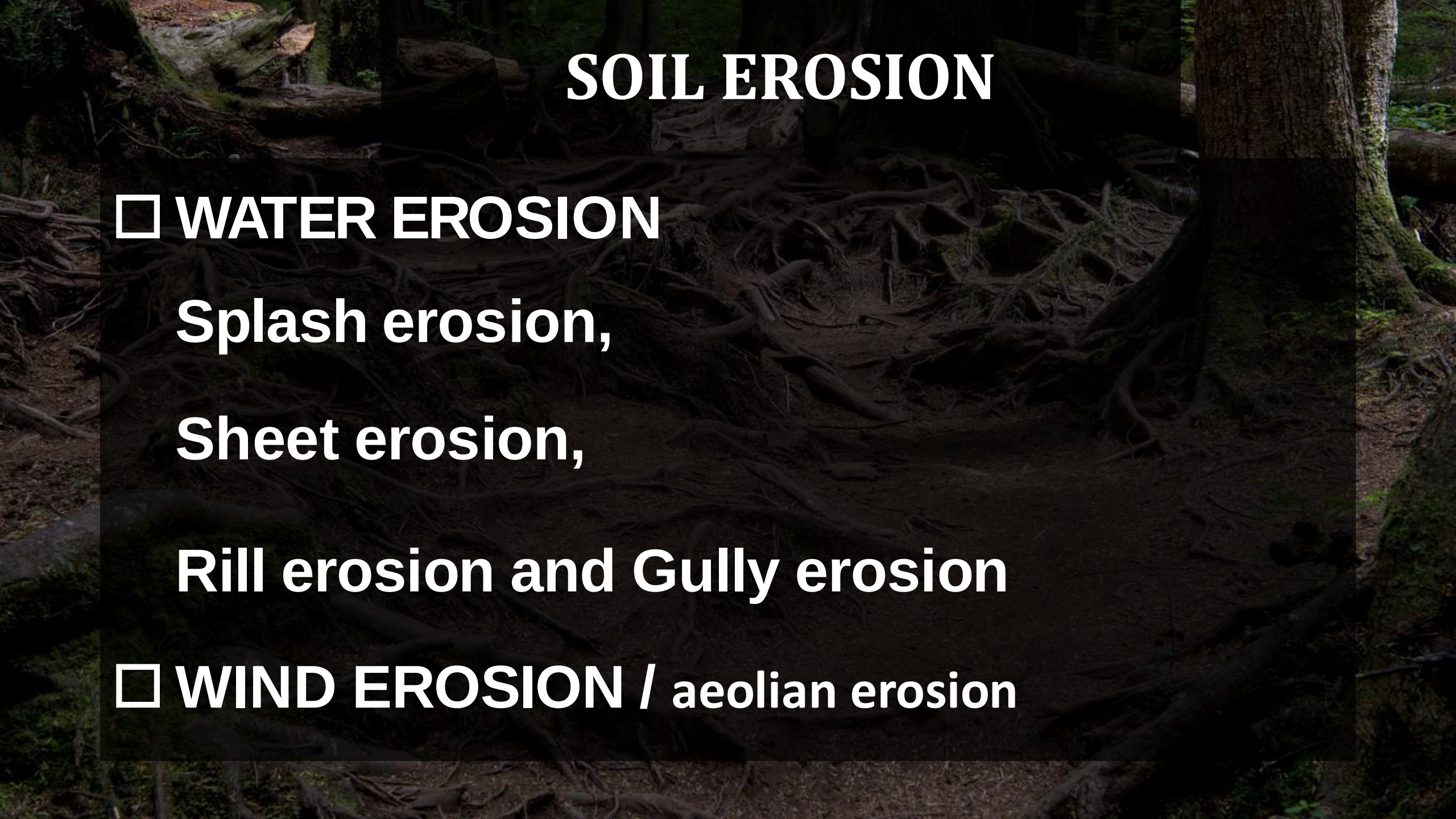


ROCK TYPES



Types of Soils required for crops

- Clayey and loamy soils are both suitable for growing cereals like wheat, and gram. Such soils are good at retaining water.
- For paddy, soils rich in clay and organic matter and having a good capacity to retain water are ideal.
- For lentils (masoor) and other pulses, loamy soils, which drain water easily, are required.
- For cotton, sandy loam or loam, which drain water easily and can hold plenty of air, are more suitable.

A dark, moody photograph of a forest floor. Numerous large, gnarled tree roots are exposed on the surface, creating a complex, web-like pattern. The background is dark and out of focus, showing more trees and foliage. The overall tone is somber and naturalistic.

SOIL EROSION

□ WATER EROSION

Splash erosion,

Sheet erosion,

Rill erosion and Gully erosion

□ WIND EROSION / aeolian erosion

SOIL EROSION

- ☐ Streambank erosion
- ☐ Landslide
- ☐ Coastal erosion
- ☐ Glacial erosion



RILL EROSION



GULLY EROSION





WIND EROSION / aeolian erosion

- Depression formation in deserts is the first step in Oasis formation.
- Oasis forms in depressions when there is underground water that gets accumulated above rocks.
- Very fine and medium sands are moved by wind in a succession of bounds and leaps, known as **saltation**.
- Small sand and dust particles are transported over long distances through the air by a process known as **suspension**.
- Coarse sand is not usually airborne but rather is rolled along the soil surface. This type of erosion is called **surface creep**.
- Very coarse sand and gravels are too large to be rolled by wind, so wind-eroded soils have surfaces covered with coarse fragments. This kind of arid soil surface is known as desert pavement.

Soil Conservation

Contour Ploughing
Strip Cropping
Mulching
Terrace Farming
Sand Fence
Wind Break

Soil Conservation

- Crop Rotation
- Use of Early Maturing Varieties
- Checking Shifting Cultivation
- Ploughing the Land in Right Direction
- Afforestation
- Checking Overgrazing
- Dams

CONTOUR PLOWING



STRIP CROPPING



TERRACE FARMING

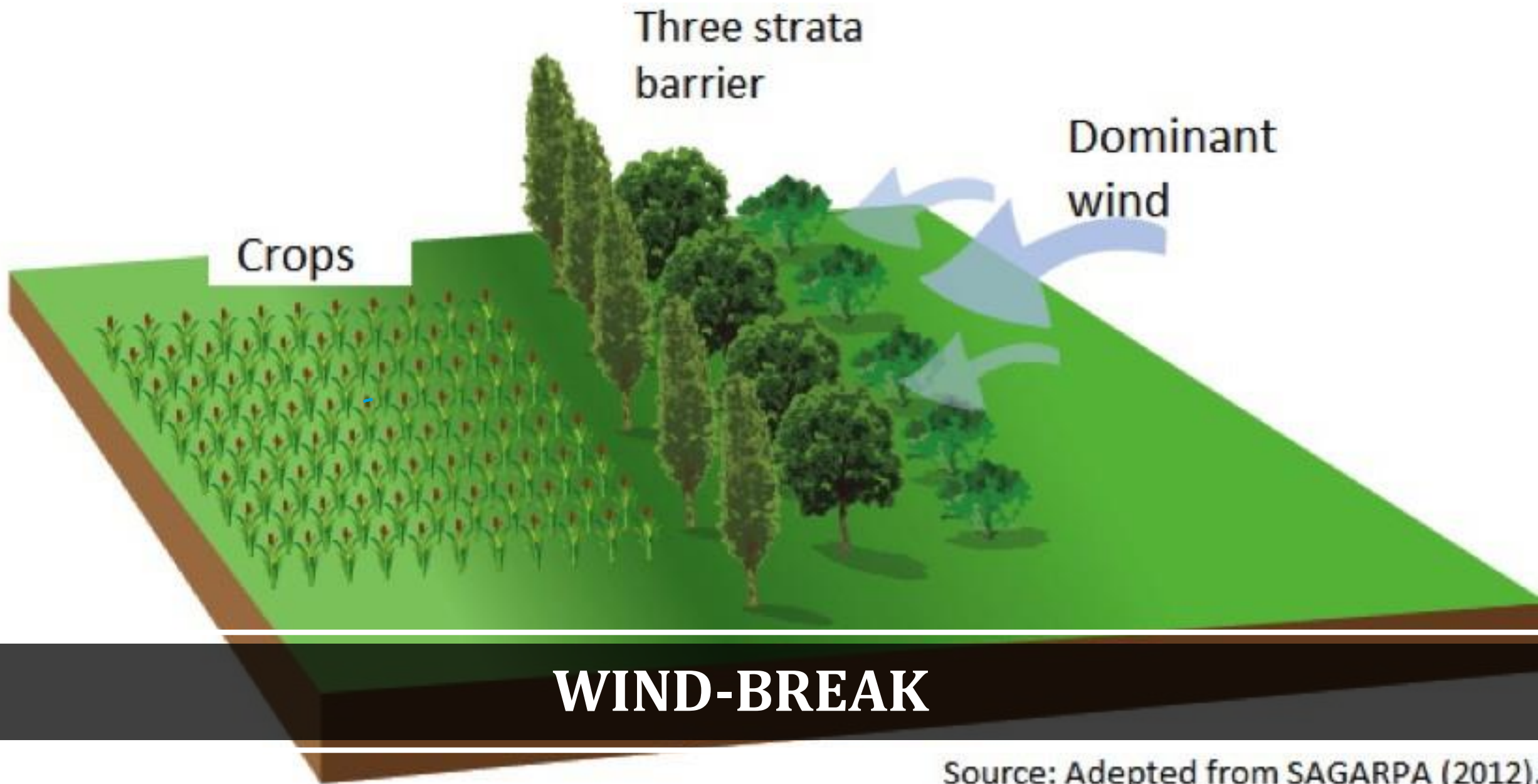


MULCHING





SAND FENCE



WIND-BREAK

Source: Adepted from SAGARPA (2012).

CLIMATOLOGY

UNIT -1

ATMOSPHERE – COMPOSITION AND STRUCTURE

Introduction

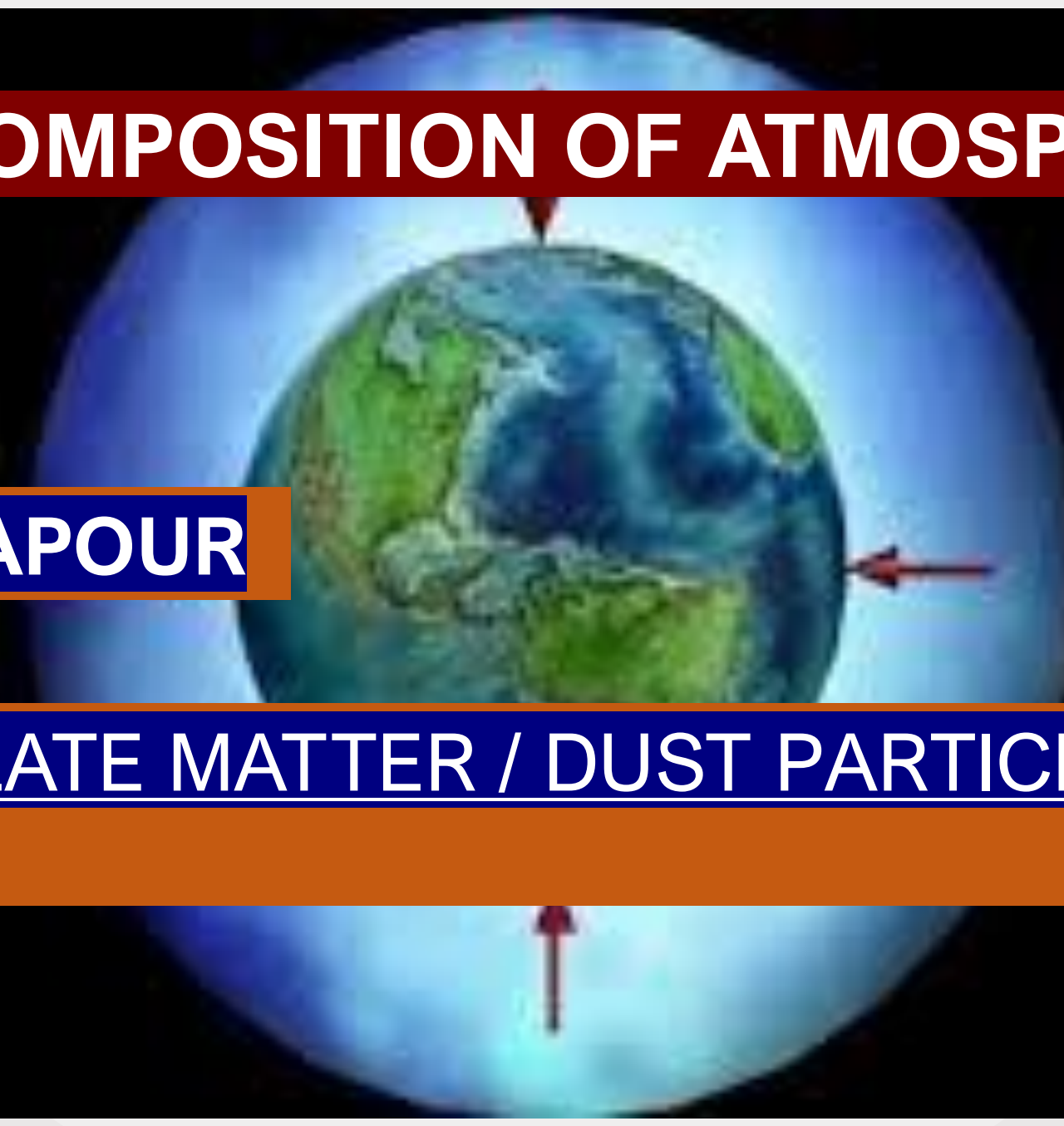
- **Thick gaseous envelope surrounding the Earth**
- **Attached to the earth's surface by gravitational force**
- **99% mass is within the height of 32 km**
- **Acts like a greenhouse by trapping the heat**

ORIGIN OF THE ATMOSPHERE

Three stages in the evolution of present atmosphere

- **Loss of primordial atmosphere**
- **Degassing by Volcanic eruptions, Hot springs, chemical breakdown of solid matter.**
- **Photosynthesis and Human Activity**

COMPOSITION OF ATMOSPHERE

A diagram of Earth showing its atmosphere. Three red arrows point towards the Earth from the top, right, and bottom, representing the different components of the atmosphere listed in the text blocks.

GASES

WATER VAPOUR

PARTICULATE MATTER / DUST PARTICLES

COMPOSITION

➤ GASES

CONSTITUENT	FORMULA	PERCENTAGE BY VOLUME
Nitrogen	N₂	78.08
Oxygen	O₂	20.95
Argon	Ar	0.93
Carbon dioxide	CO₂	0.036
Neon	Ne	0.002
Helium	He	0.0005
Krypton	Kr	0.001
Xenon	Xe	0.00009
Hydrogen	H ₂	0.00005

COMPOSITION

➤ WATER VAPOUR

- **Variable gas**
- **Absorbs insolation and terrestrial radiation**
- **Latent heat**

COMPOSITION

➤ PARTICULATE MATTER / DUST PARTICLES

- **High concentration in subtropical and temperate regions**
- **Hygroscopic nuclei**
- **Scatters incoming solar rays**
- **Particles like sea salts, fine soil, smoke-soot, ash, pollen, dust & disintegrated particles of Meteors**

Expected Question

Which of the statements is/are true regarding the composition of the atmosphere:

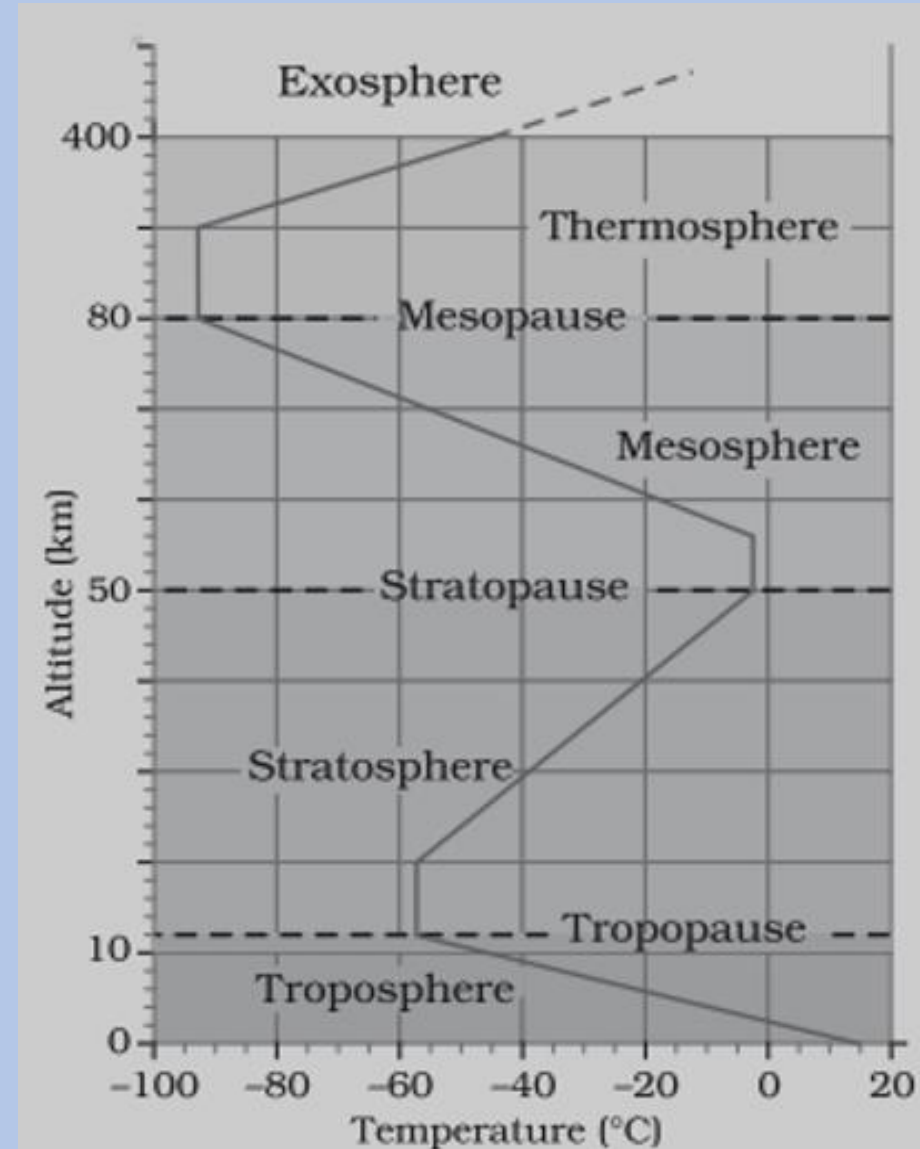
- I. Water vapour in the atmosphere decreases with altitude.**
- II. It decreases from the equator towards the poles.**
- III. Water vapour absorbs all forms of solar radiations.**

Choose the correct statements using the codes given below:

- a. I & II**
- b. II & III**
- c. I & III**
- d. All of the above.**

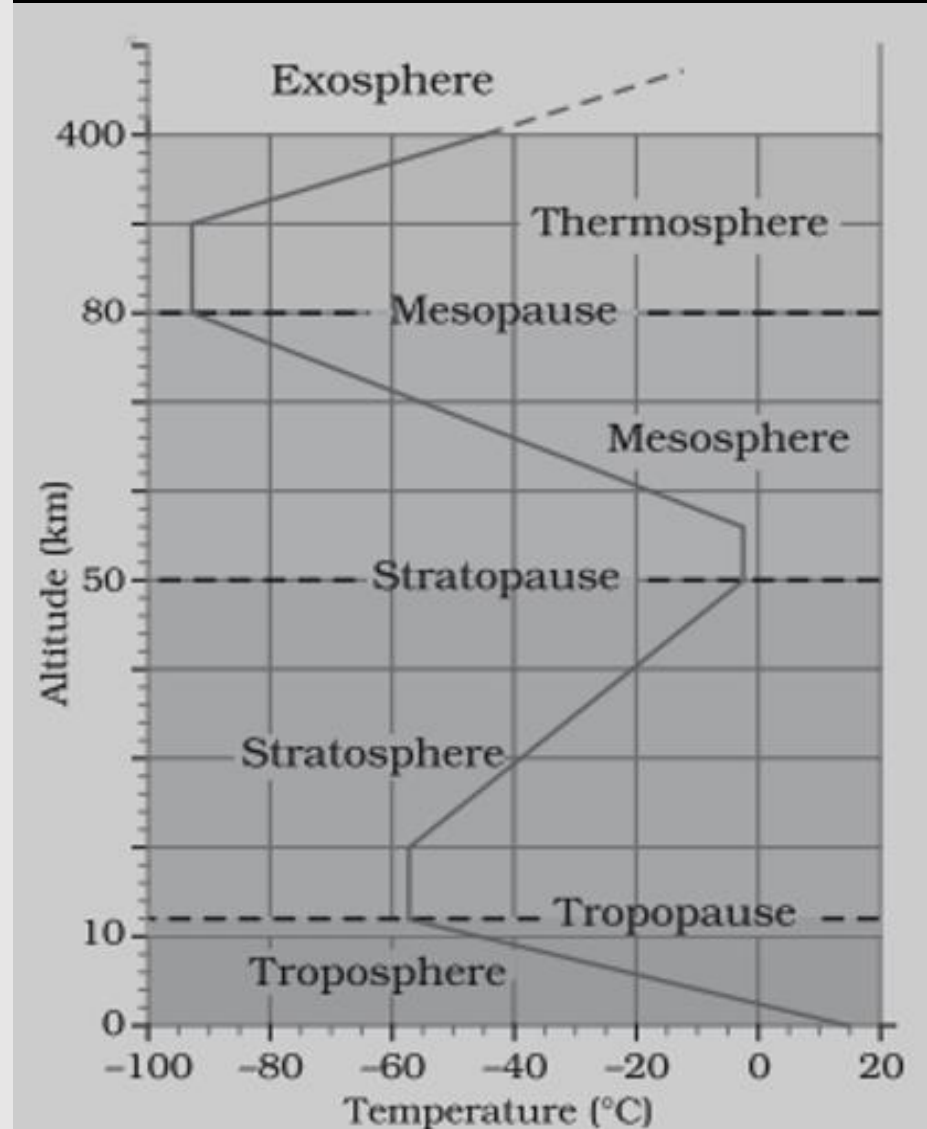
STRUCTURE

- **Consists of different layers**
- **Density decreases with altitude**
- **Homosphere and Heterosphere**



TROPOSPHERE

- **Strong convecti**onal currents
- **Height of troposphere**
- **Temperature decreases with altitude**
- **Contains dust particles and water vapour**
- **Jet aeroplanes often avoid this layer**
- **Tropopause**

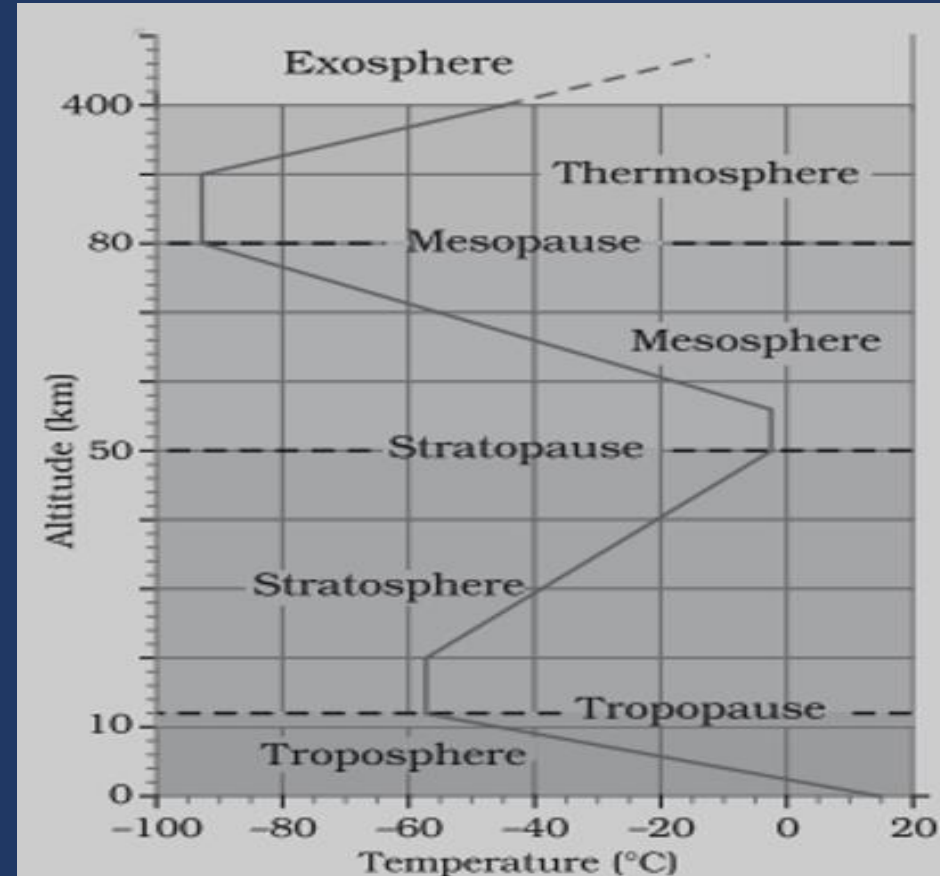


ANVIL SHAPED CLOUD



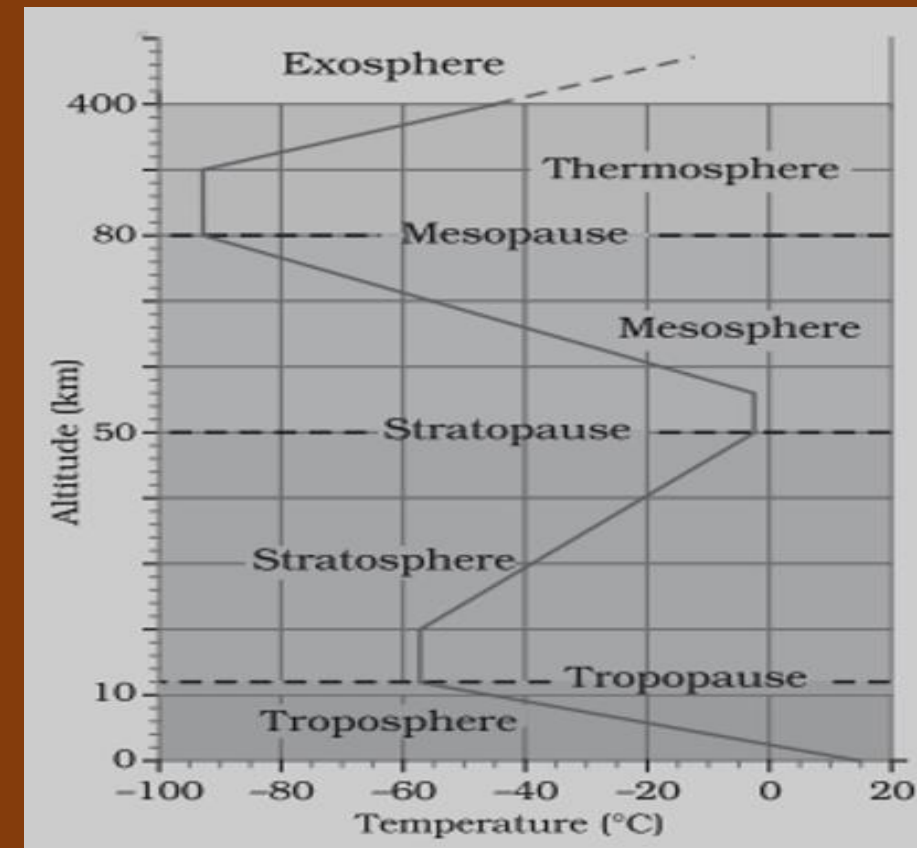
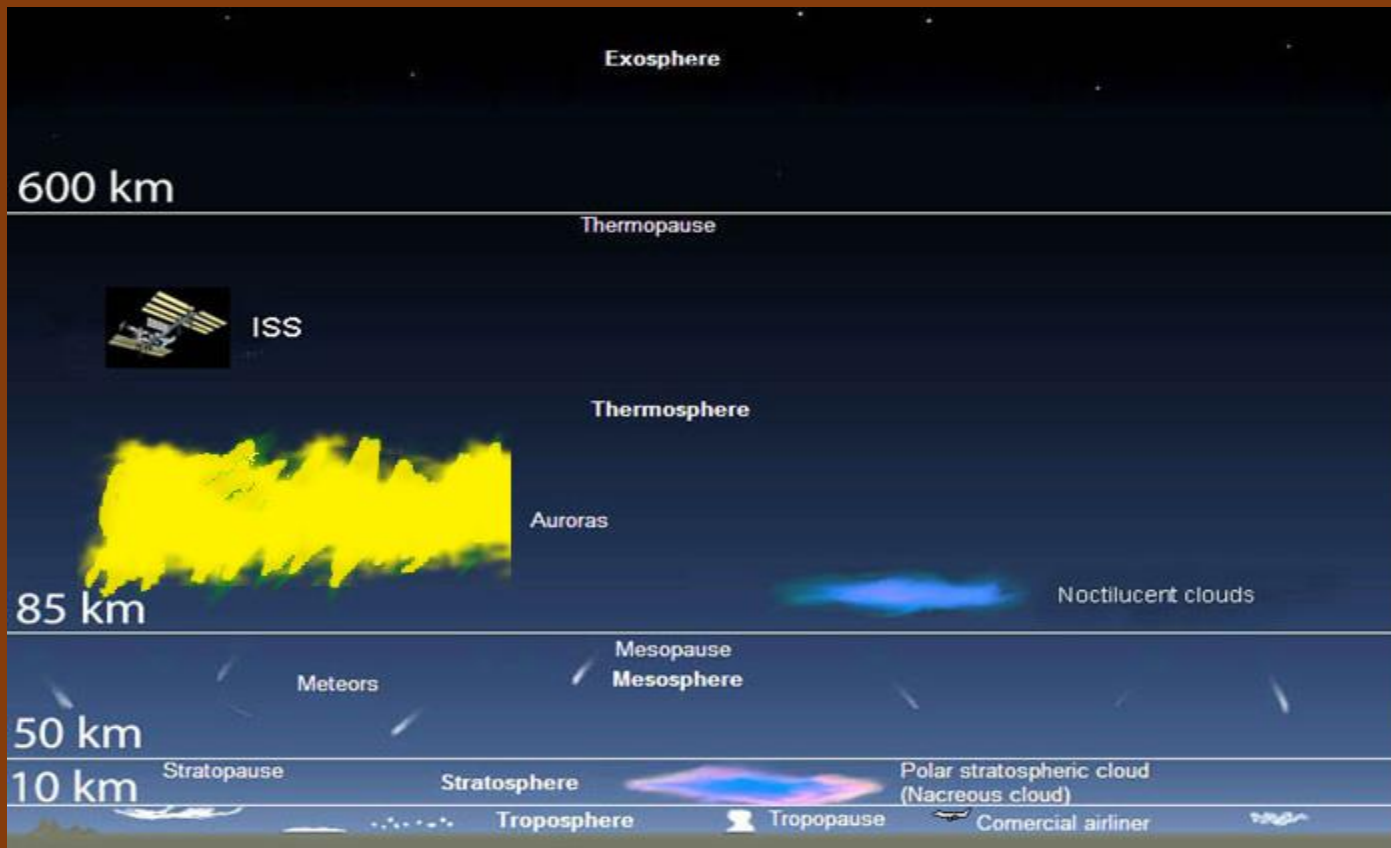
STRATOSPHERE

- **Presence of ozone layer**
- **Temperature increases with altitude**
- **Low vertical mixing**
- **Less cloud formation**
- **Stratopause**



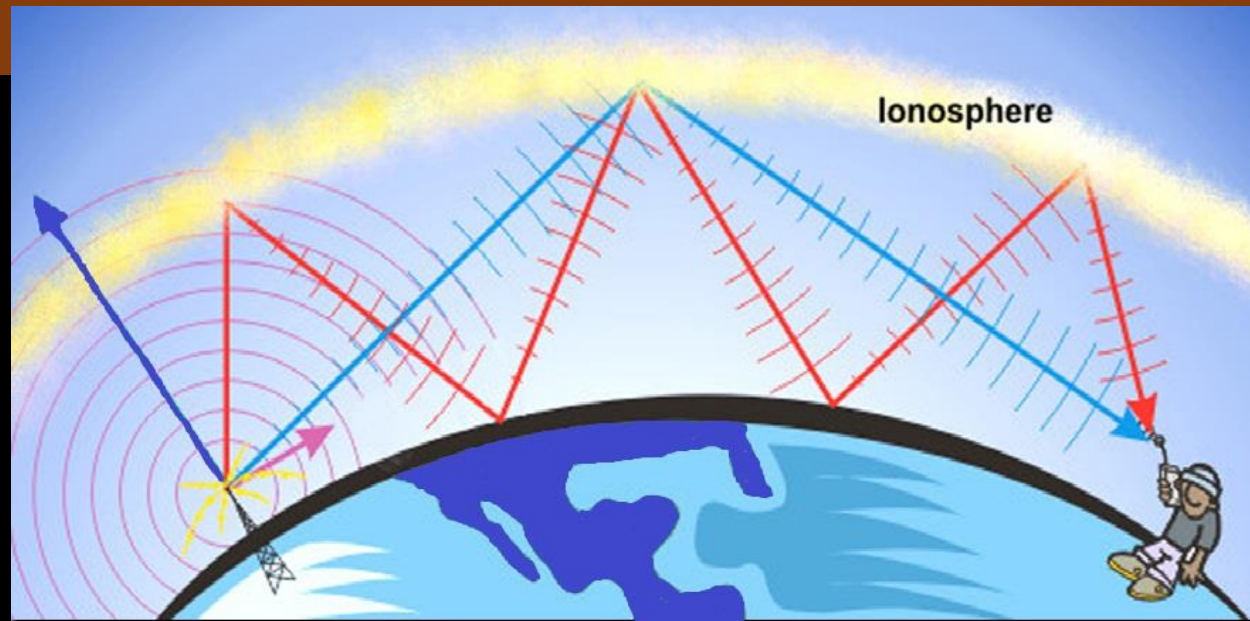
Mesosphere

- **Temperature decreases with altitude**
- **Coldest region in atmosphere**



Ionosphere

- **Electrically charged particles**
- **Peak concentration at 250 km**
- **Aurora Borealis and Aurora Australis**





Expected Question

Read the following statements:

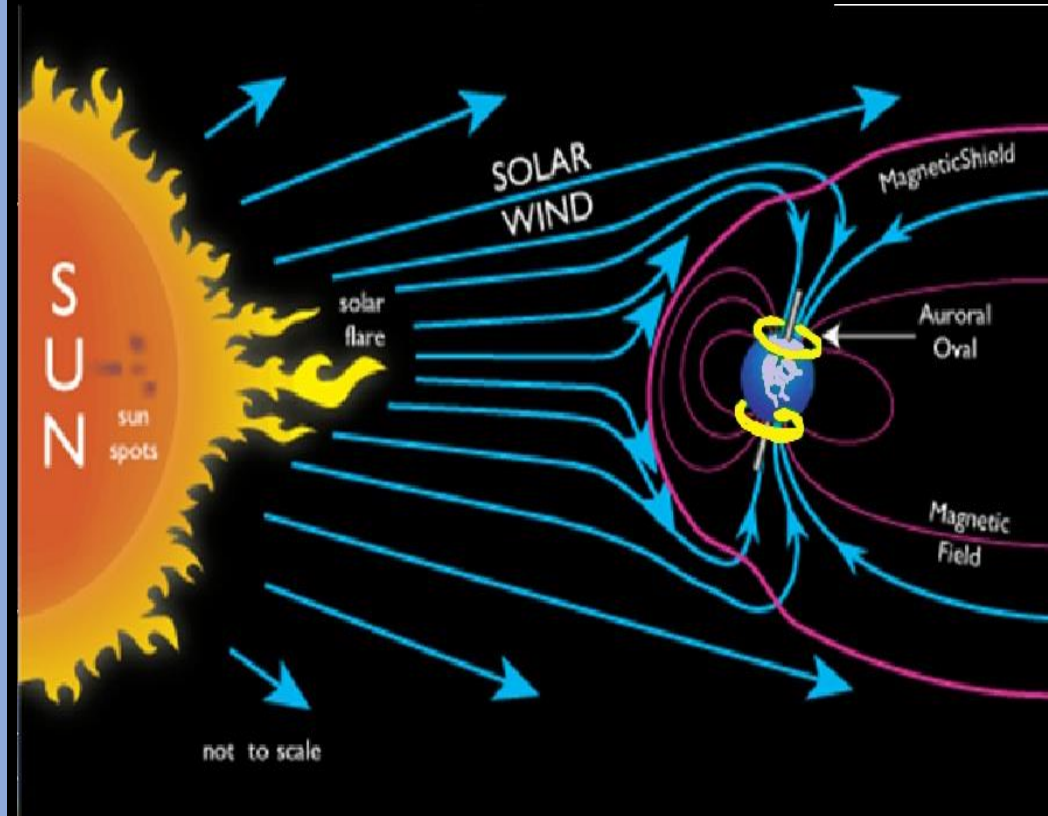
- I. Jet planes avoid flying in the stratosphere.**
- II. Meteor showers takes place in mesosphere.**

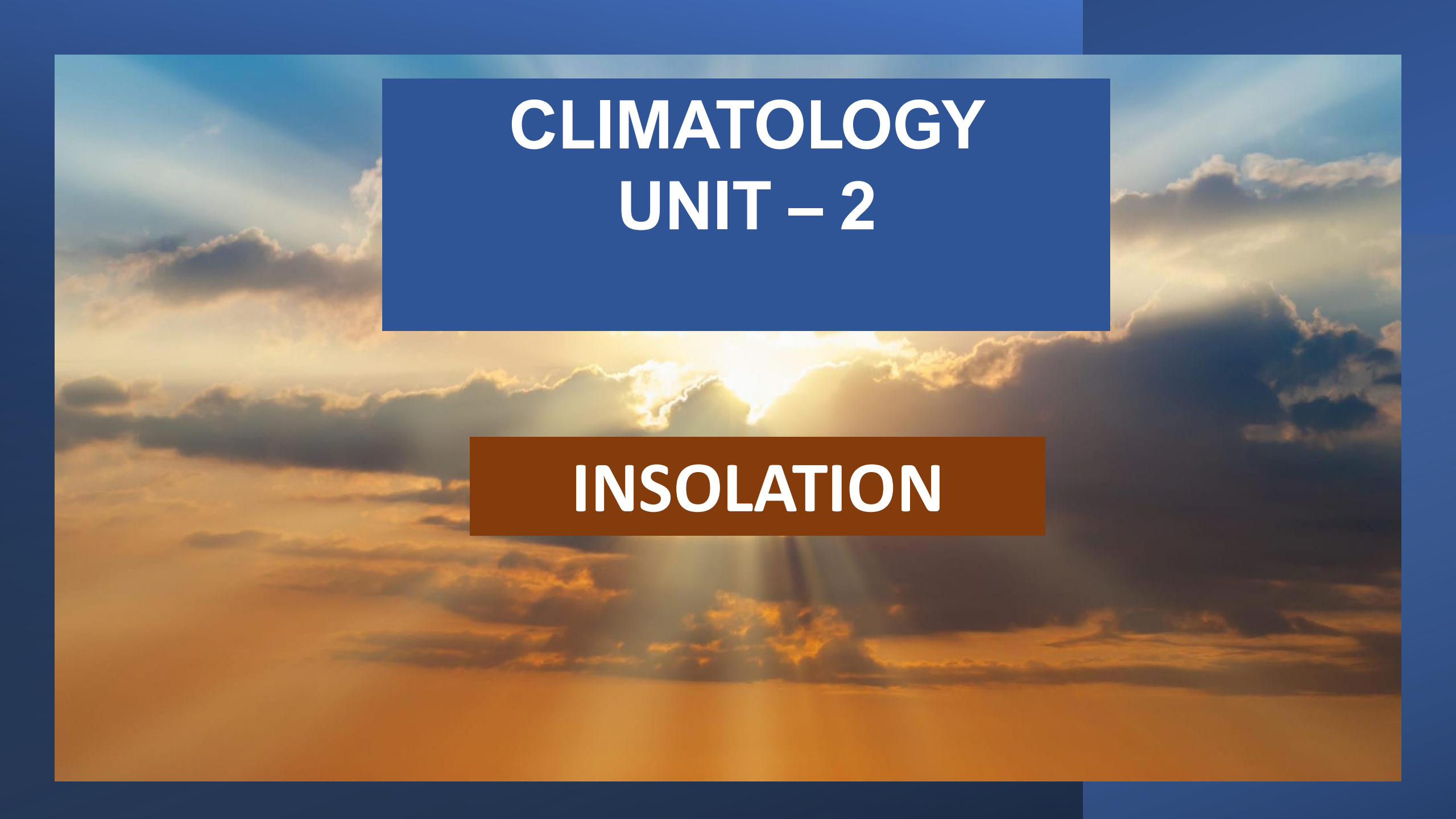
Which of the above statement(s) is/are true:

- a. I Only**
- b. II Only**
- c. I & II**
- d. None of the above.**

Exosphere

- **Gases are very thin**
- **Gradually merges with the outer space**
- **Magnetosphere**



A background image of a sunset or sunrise sky. The sun is partially obscured by dark, dramatic clouds in the center, with bright rays of light breaking through. The sky transitions from a deep blue at the top to a warm orange and yellow near the horizon. The overall mood is serene and powerful.

CLIMATOLOGY UNIT – 2

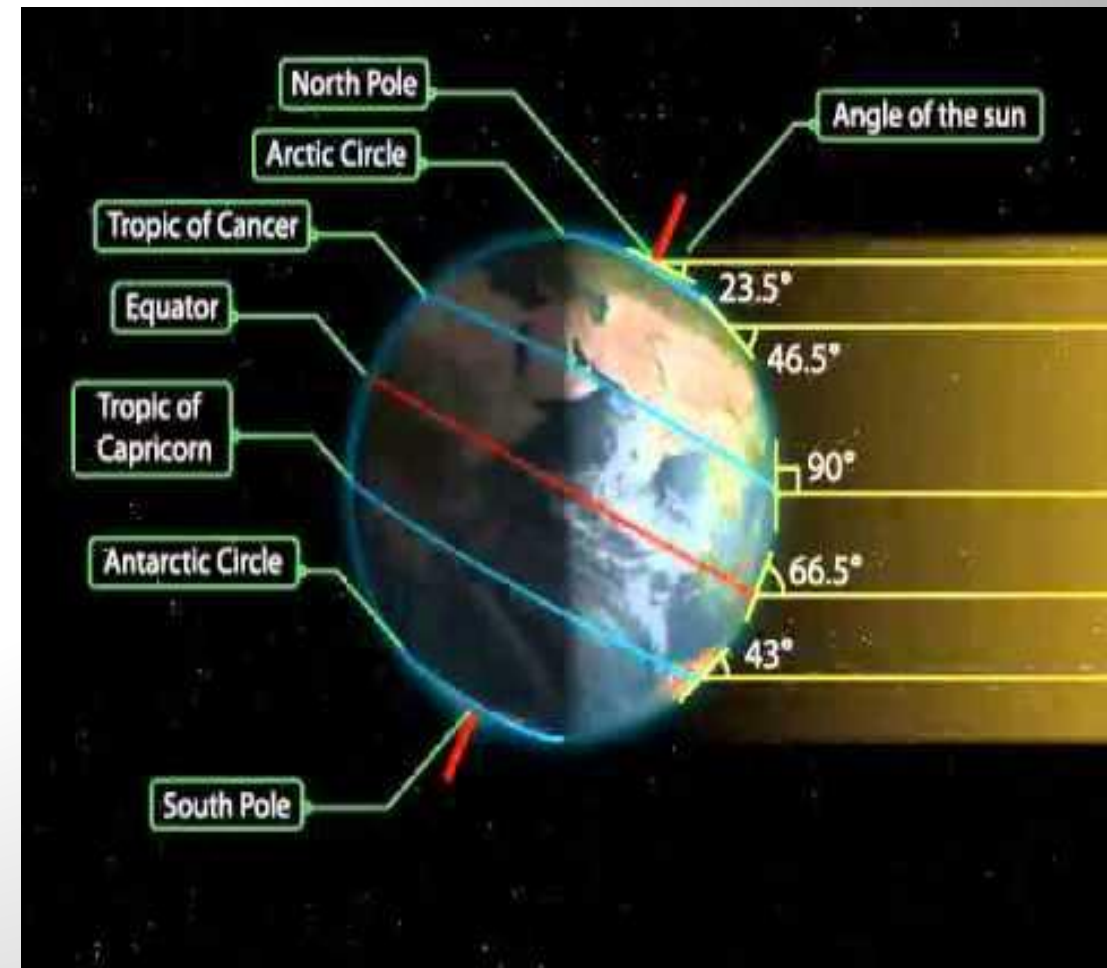
INSOLATION

INSOLATION

- **Incoming solar radiation**
- **Equator receives comparatively less insolation than the tropics**
- **Maximum insolation is received over the subtropical deserts**
- **At the same latitude, more insolation over the continents than over the oceans**

FACTORS AFFECTING INSOLATION

- The Revolution & Rotation of earth on its tilted axis
- The angle of inclination of sun's rays
- The length of the day
- Effects of the atmosphere
- Sunspots
- Impact of land and water



March Equinox
(Spring - N)
(Fall - S)

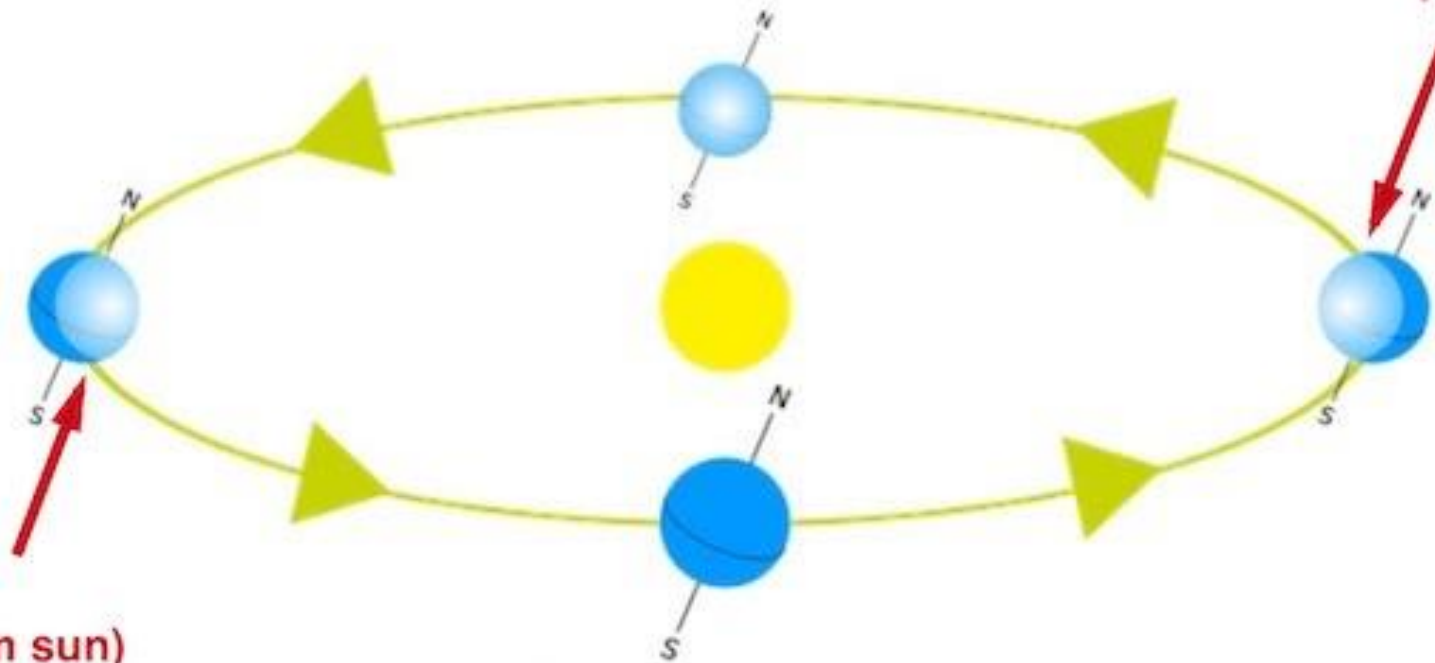
Perihelion
(Earth closest to sun)
= early January

December Solstice
(Winter - N)
(Summer - S)

September equinox
(Fall - N)
(Spring - S)

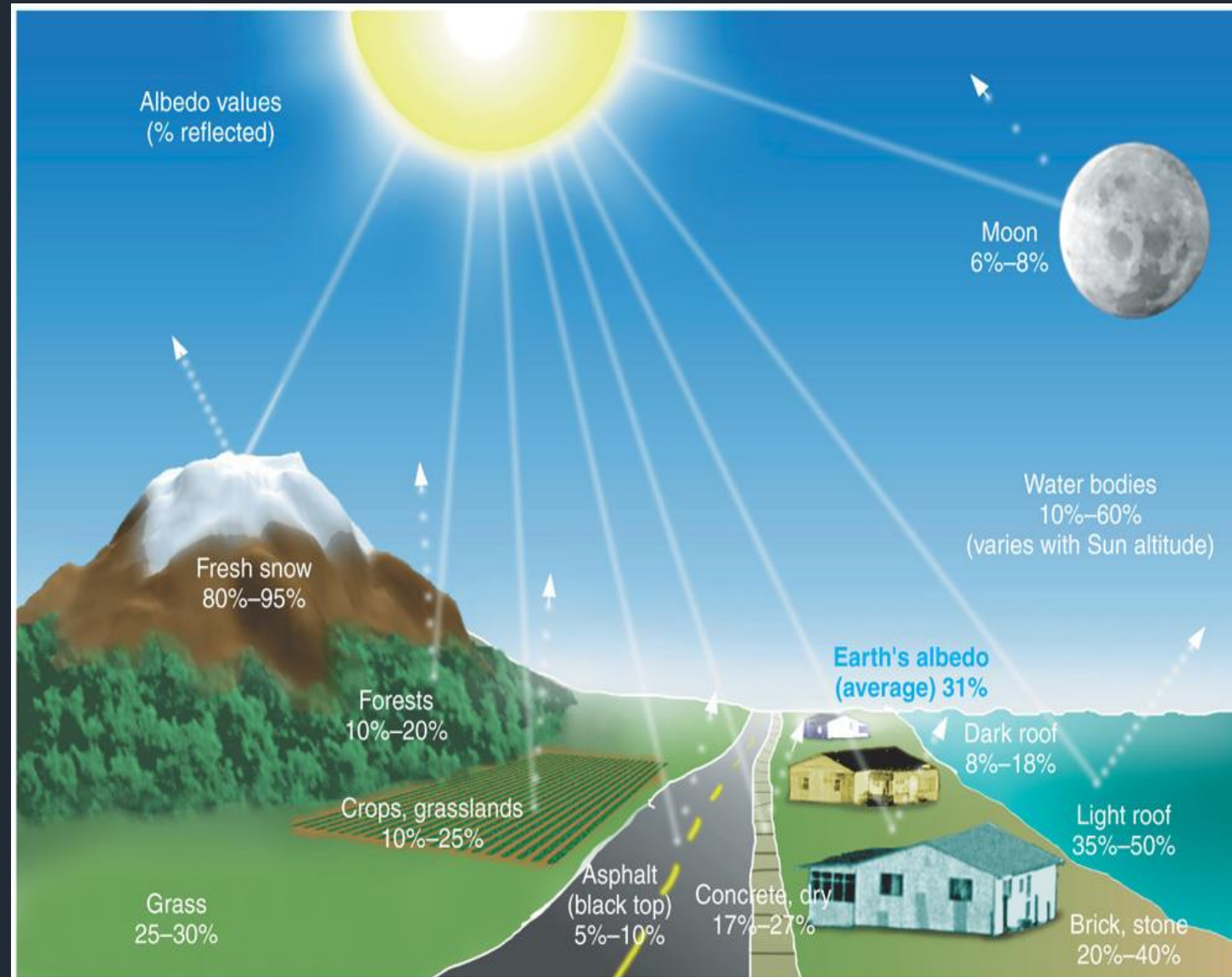
June Solstice
(Summer - N)
(Winter - S)

Aphelion
(Earth farthest from sun)
= early July



ALBEDO

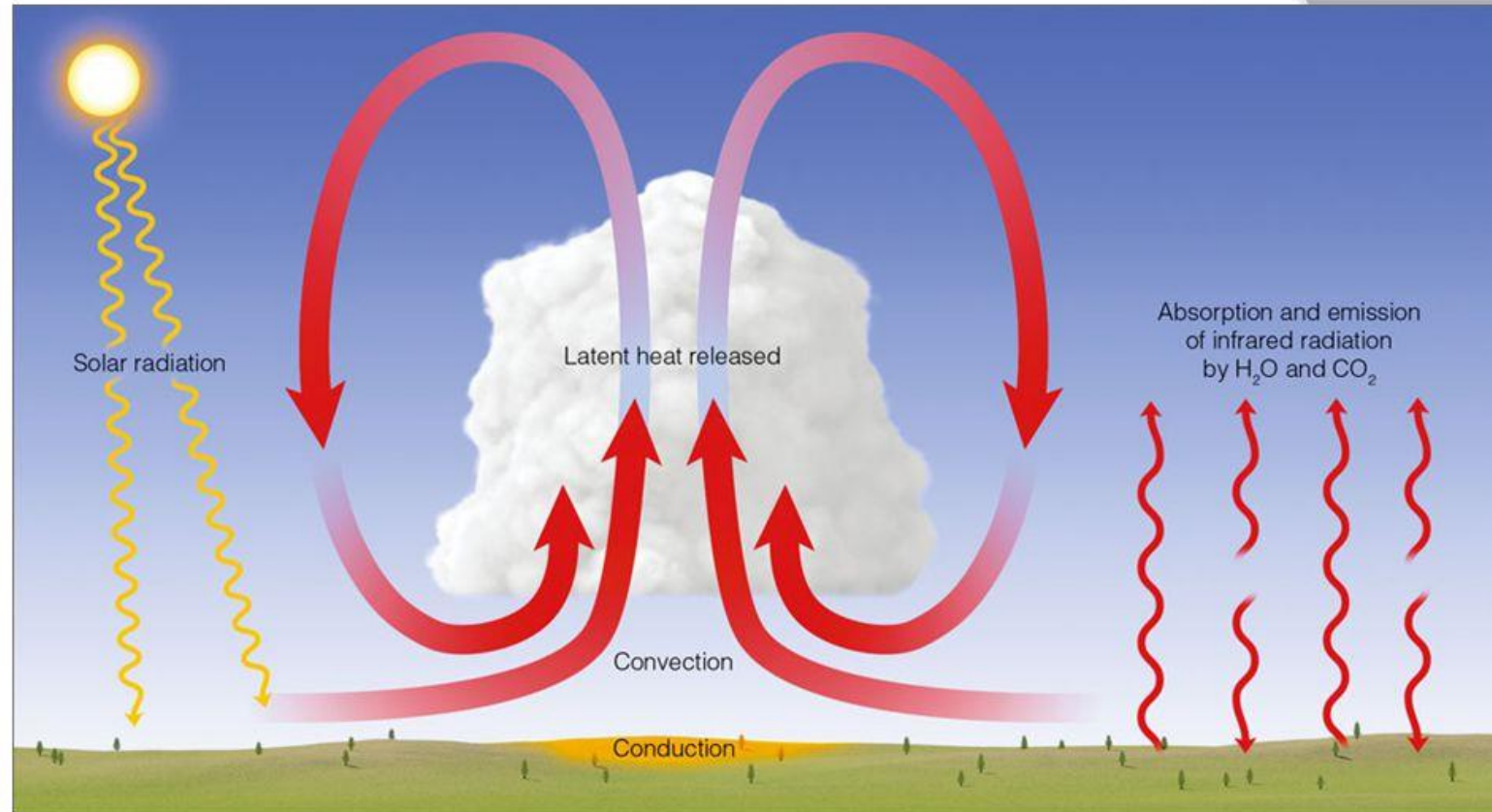
- Radiation reflected by a surface
- Reflectivity
- Visual brightness
- Earth's albedo is around 30%.
- Moon (7%), Mercury (6%), Mars (16%), Venus (76%) and the outer planets (73% to 94%)



HEATING AND COOLING OF THE ATMOSPHERE

- ☐ TERRESTRIAL RADIATION
- ☐ CONDUCTION
- ☐ CONVECTION
- ☐ ADVECTION

Air in the lower atmosphere is heated from the ground upward. Sunlight warms the ground, and the air above is warmed by conduction, convection, and infrared radiation.



© Brooks/Cole, Cengage Learning

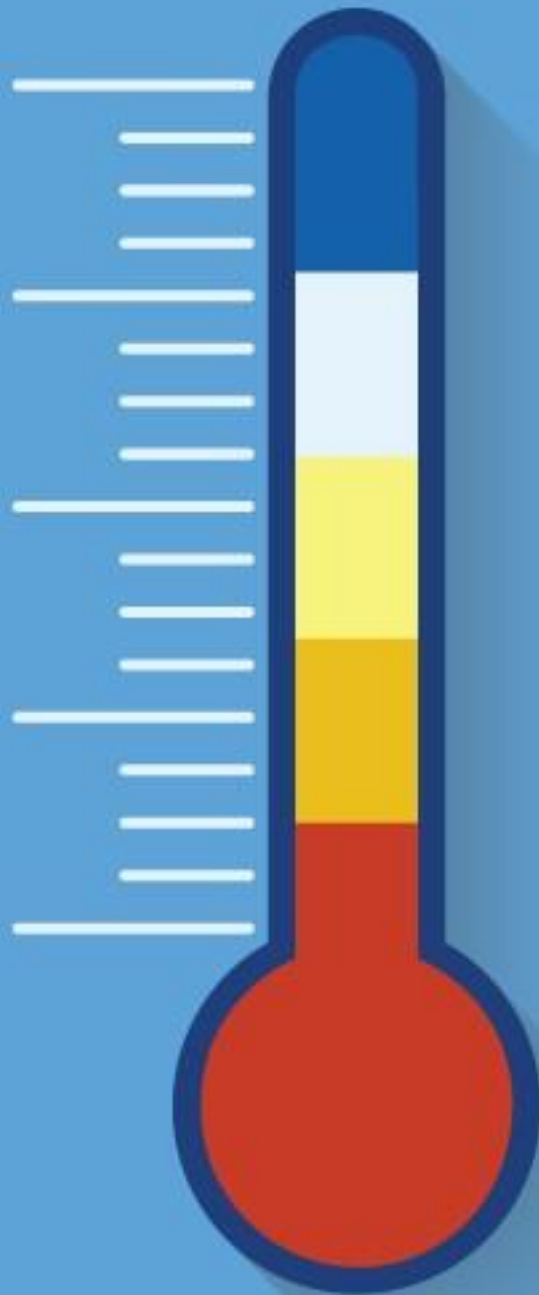
Further warming occurs during condensation as latent heat is given up to the air inside the cloud.

Previous year Question (2010)

Which one of the following reflects back more sunlight as compared to other three?

- a. Sand desert**
- b. Paddy crop land**
- c. Land covered with fresh snow**
- d. Prairie land**

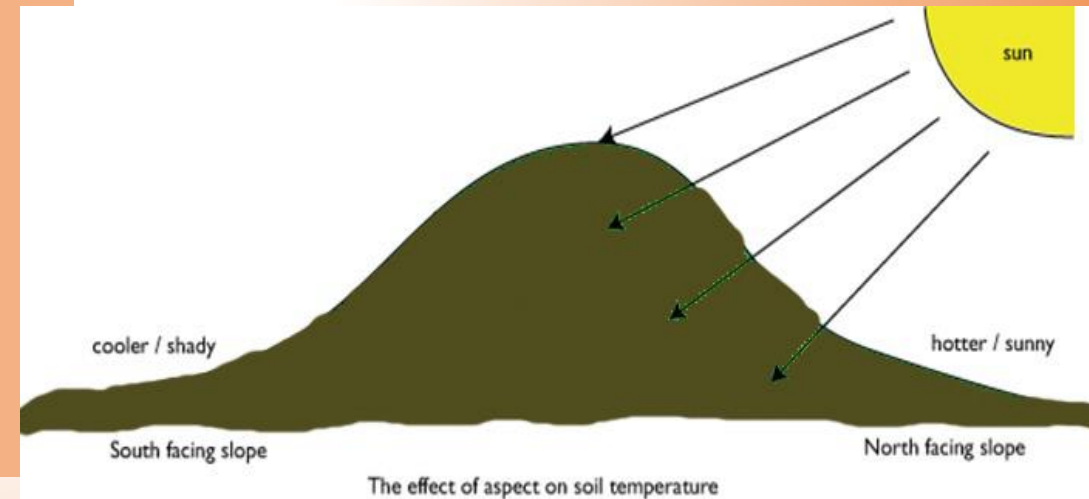
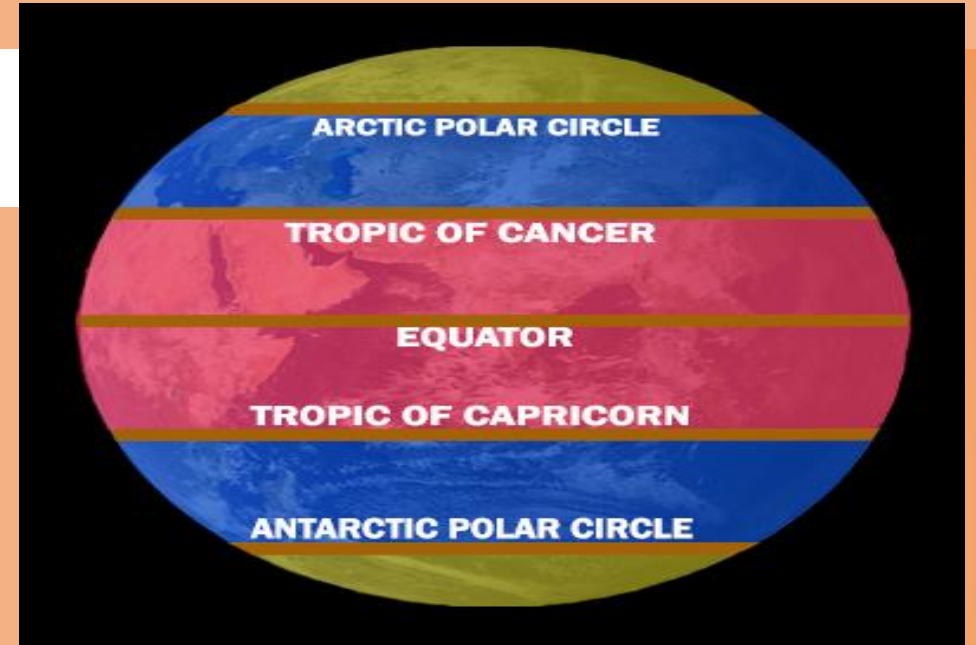
CLIMATOLOGY



TEMPERATURE

FACTORS CONTROLLING TEMPERATURE DISTRIBUTION

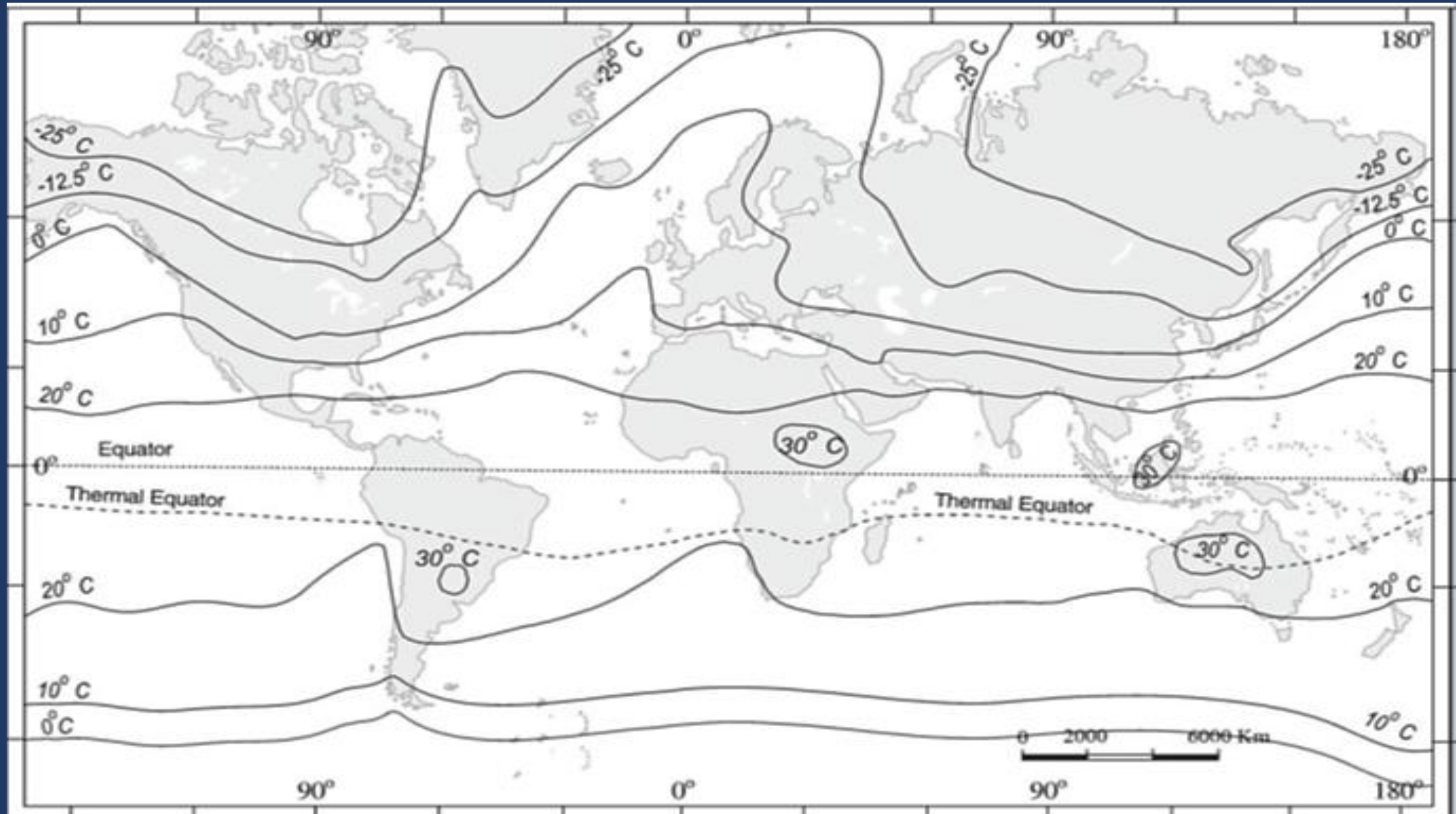
- Latitude
- Altitude
- Distance from the sea
- Prevailing winds
- Oceans currents
- Nature of ground surface and slope



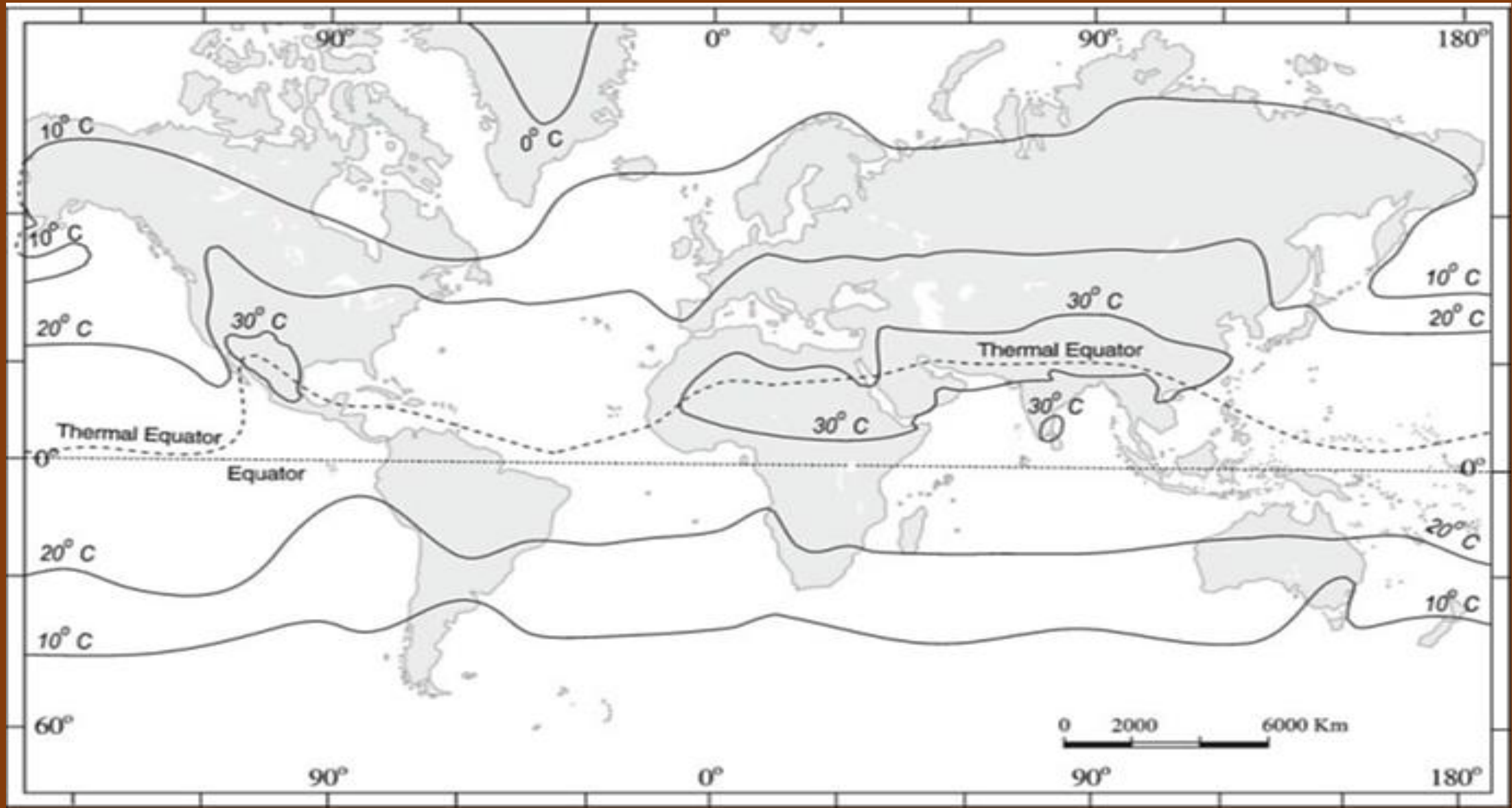
Heat Budget

The earth receives a certain amount of Insolation (**short waves**) and gives back heat into space by terrestrial radiation (**longwave radiation**). Through this give and take, or the heat budget, the earth maintains a constant temperature.

JANUARY-ISOTHERMS



JULY-ISOTHERMS



Daily mean temperature:

- It is calculated by adding the maximum and minimum temperature of the day and dividing the total by two.

Monthly mean temperature:

- It is calculated by adding the daily mean temperatures for the each day of the month and dividing the total by the number of days in a month.

Annual mean temperature:

- It is calculated by adding the mean monthly temperatures of all the twelve months and dividing the total by 12.

Annual range of temperature:

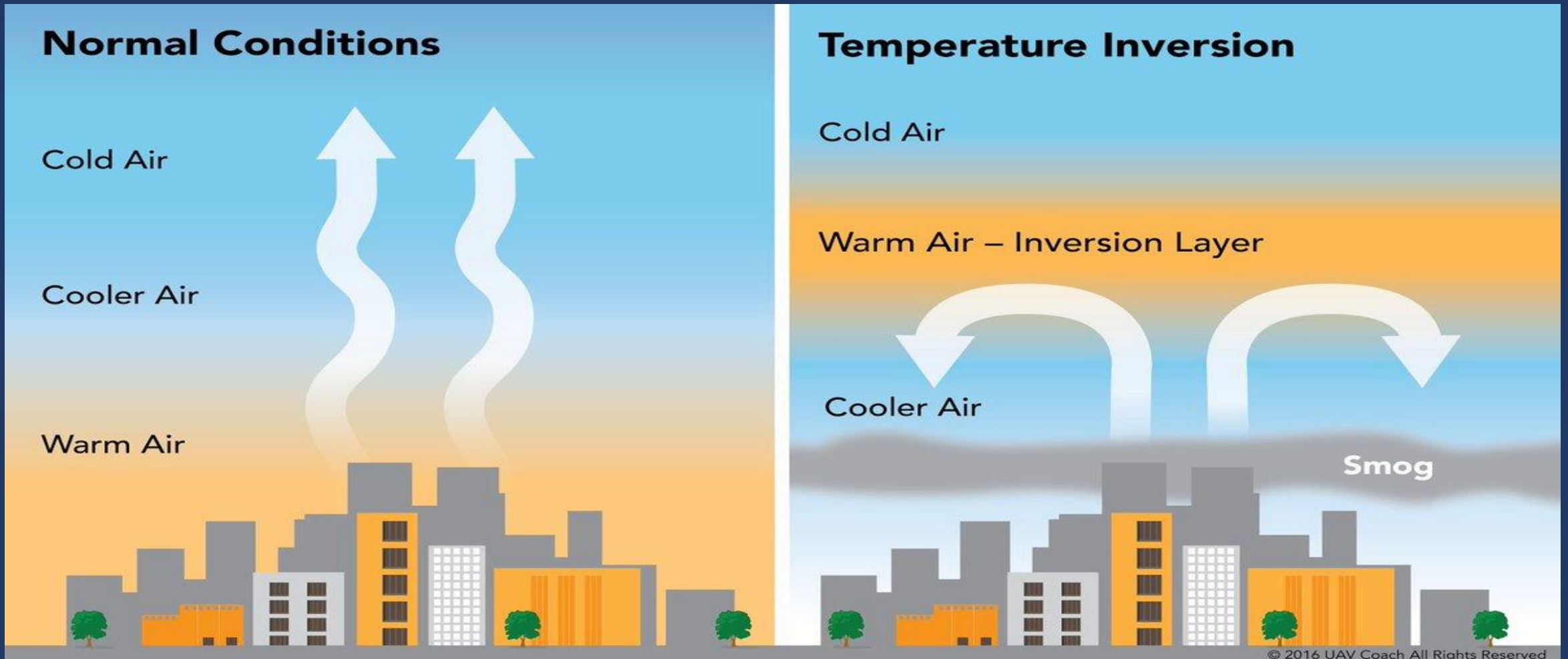
- It is calculated by subtracting the minimum monthly mean temperature from the maximum monthly mean temperature in a year.

ANNUAL RANGE OF TEMPERATURE

- High ART in land than that in Ocean
- Larger the Ocean, smaller the ART
- Greater in Northern Hemisphere than that in Southern Hemisphere
- Diurnal range of temperature

INVERSION OF TEMPERATURE

- Normal lapse rate is inverted



CAUSES

- **Polar regions**
- **Cloudless winter night**
- **Air drainage**
- **Subsidence from upper troposphere**

EFFECTS

- **Frost formation**
- **Fog and smog**
- **Decreases rainfall**
- **Valley floors are avoided for human settlements**

Cloudy Night: Less heat can be radiated from earth because cloud acts as "barrier"



Not as Cool



Clear Night: More heat escapes from earth into space due to absence of cloud "barrier", this leads to cooler temps at surface.



Cooler

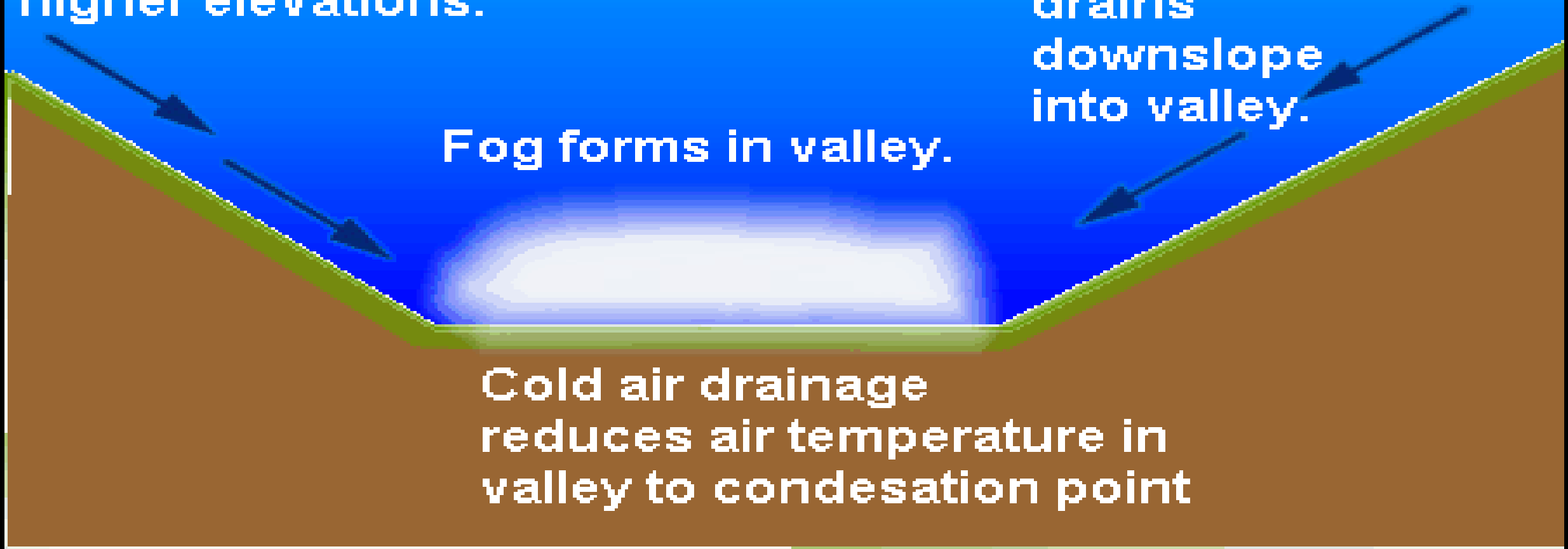
Valley Fog

Air cools at
higher elevations.

Cold Air
drains
downslope
into valley.

Fog forms in valley.

Cold air drainage
reduces air temperature in
valley to condensation point





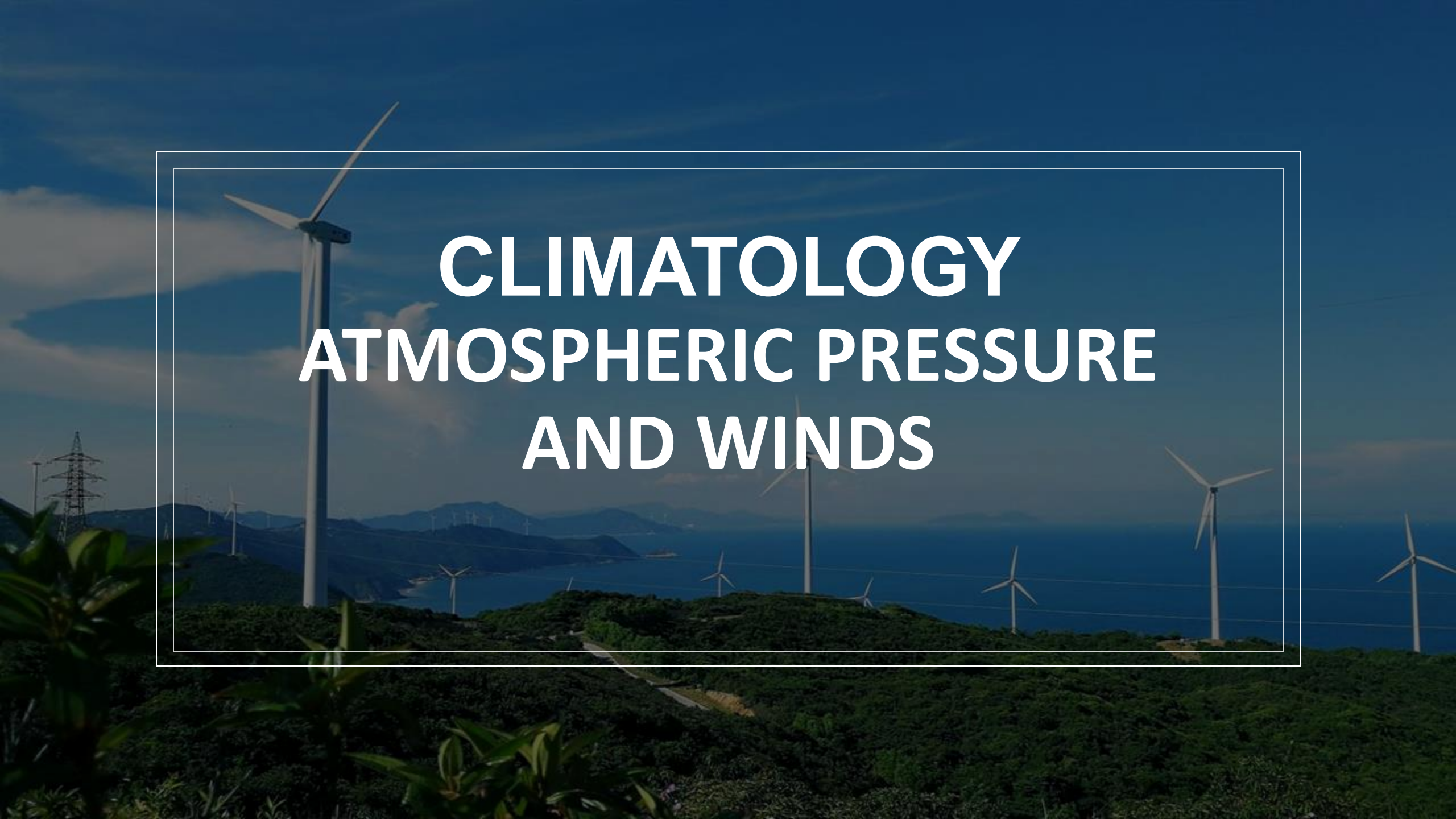
Expected Question

Which of the statements is/are correct for inversion of temperature:

- I. Inversion of temperature is related with the vertical distribution of temperature.**
- II. The land surface will be cooler in cloudless winter night is due to temperature inversion.**
- III. Frost formation is due to temperature inversion.**

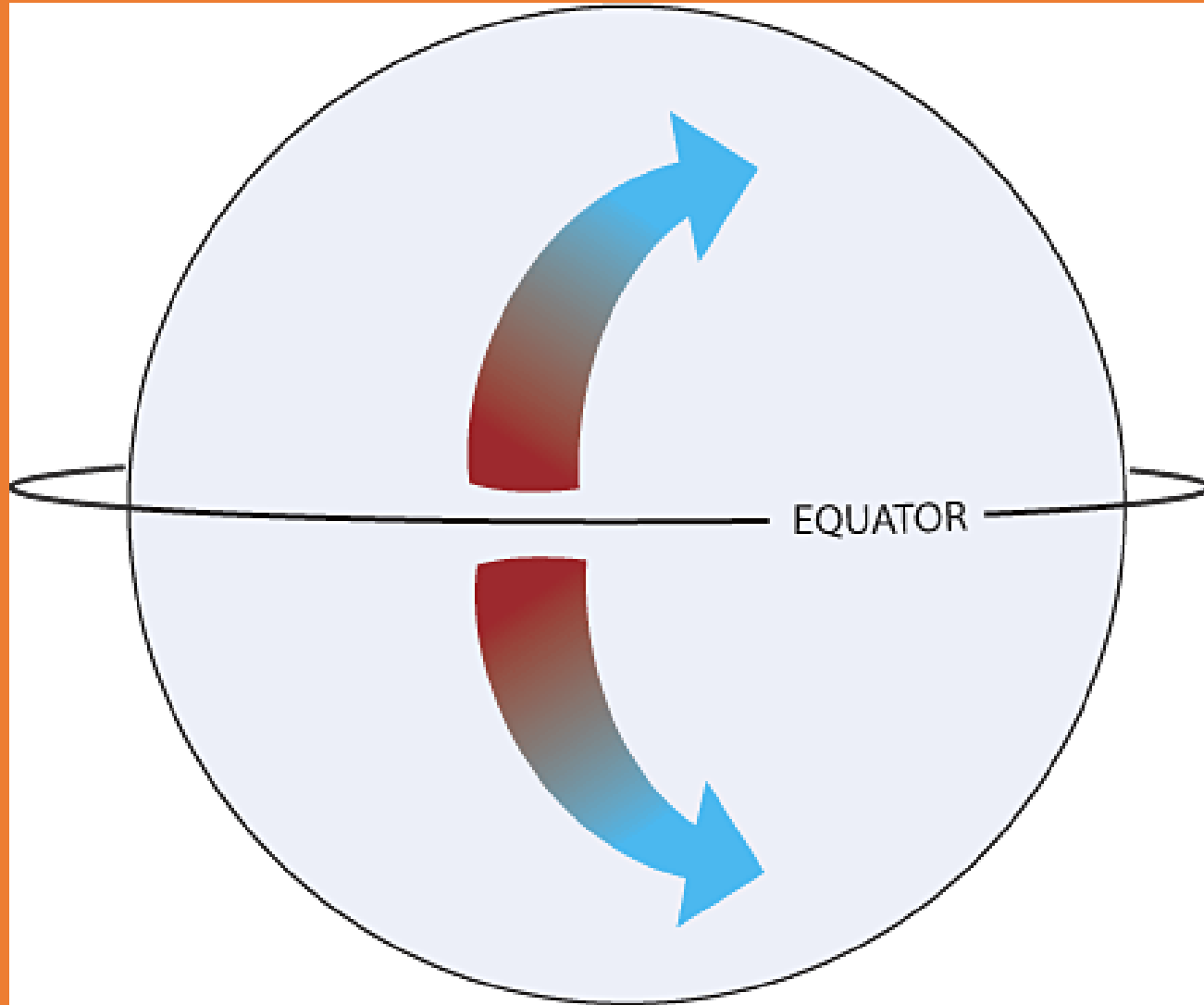
Choose the correct statements using the codes given below:

- a. I & II**
- b. II & III**
- c. I & III**
- d. All of the above.**

A photograph of a wind farm on a green hill. Several white wind turbines are visible, with one in the foreground on the left and others scattered across the landscape. In the background, there is a blue body of water and distant mountains under a blue sky with some clouds. A white rectangular border is overlaid on the image, containing the text.

CLIMATOLOGY ATMOSPHERIC PRESSURE AND WINDS

CORIOLIS EFFECT



Expected Question

Arrange the following according to decreasing Coriolis effect:

- I. Tropic of Capricorn**
- II. Equator**
- III. Poles**

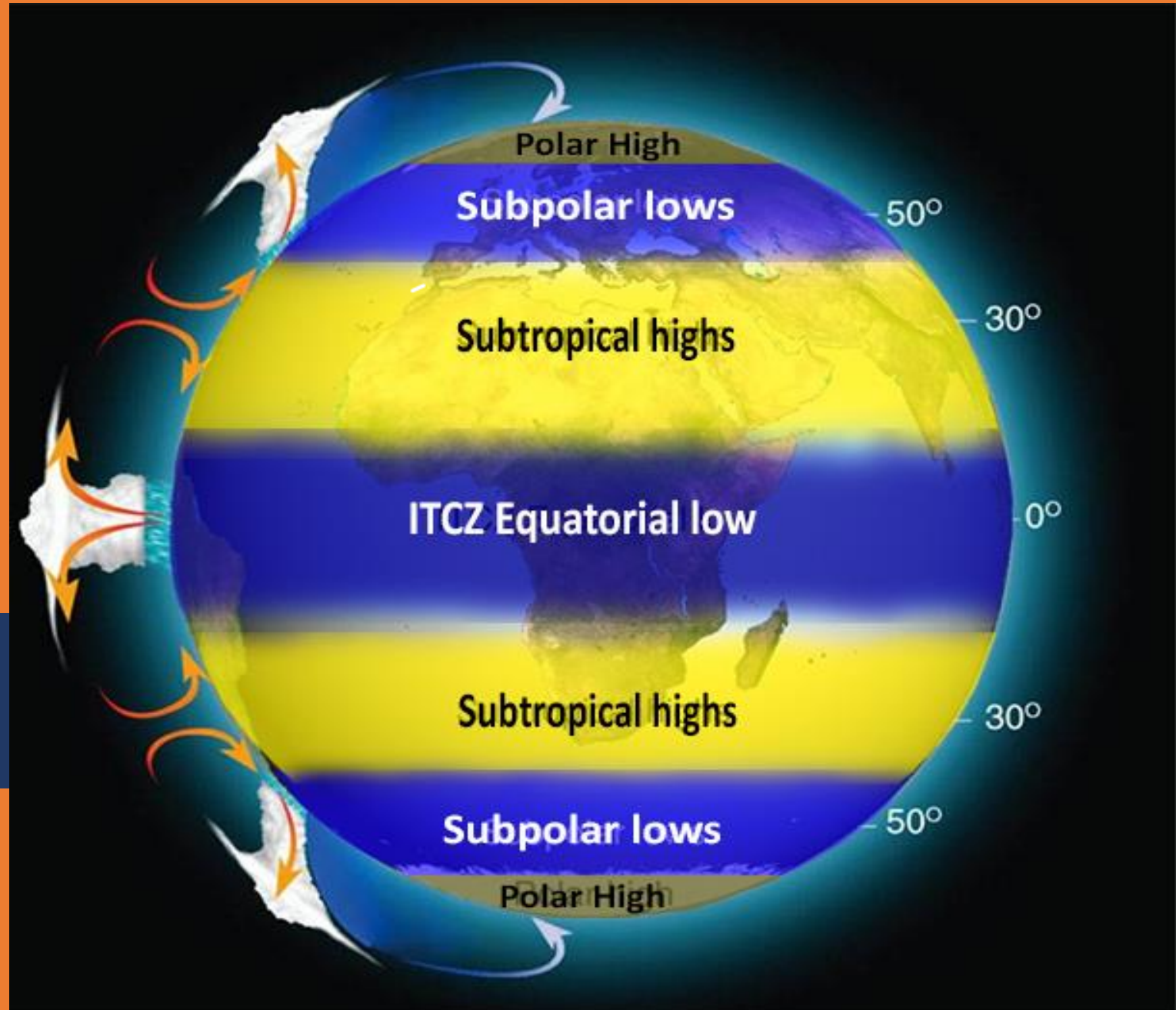
Select the correct code:

- a. I-II-III**
- b. III-I-II**
- c. II-III-I**
- d. I-III-II**

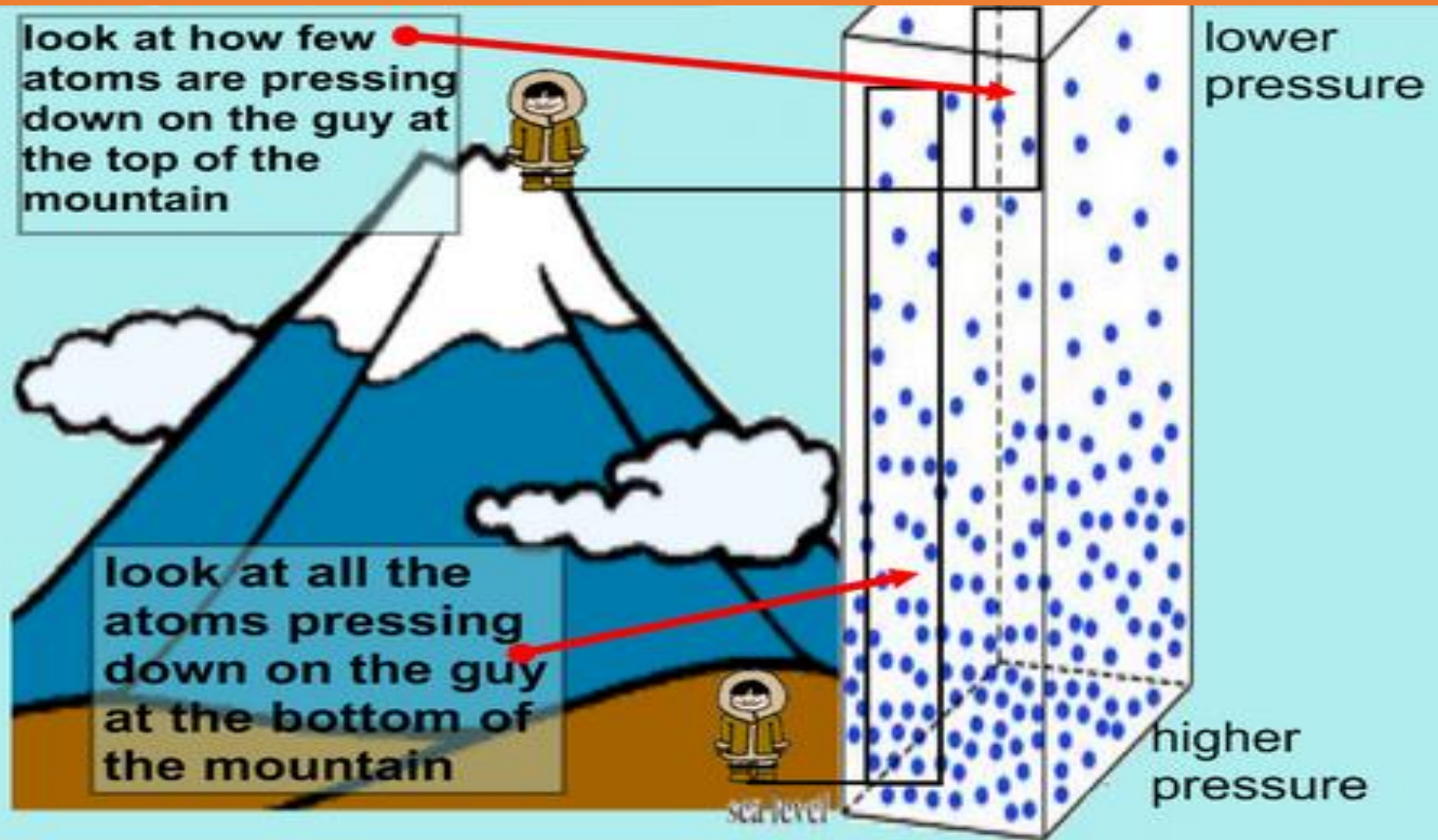
PRESSURE BELTS

- **Zonal character**

1. Thermal Energy/Heat
2. Pressure Difference

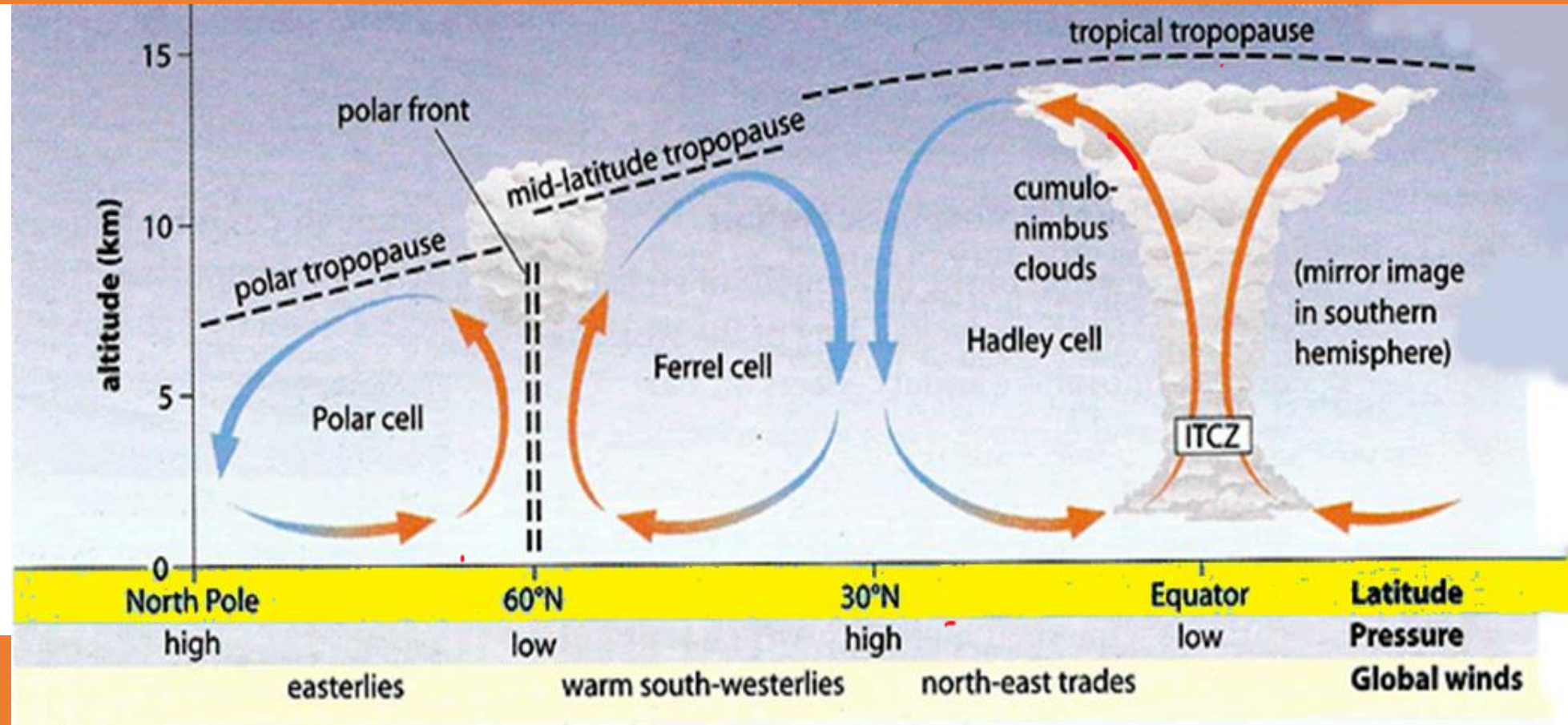


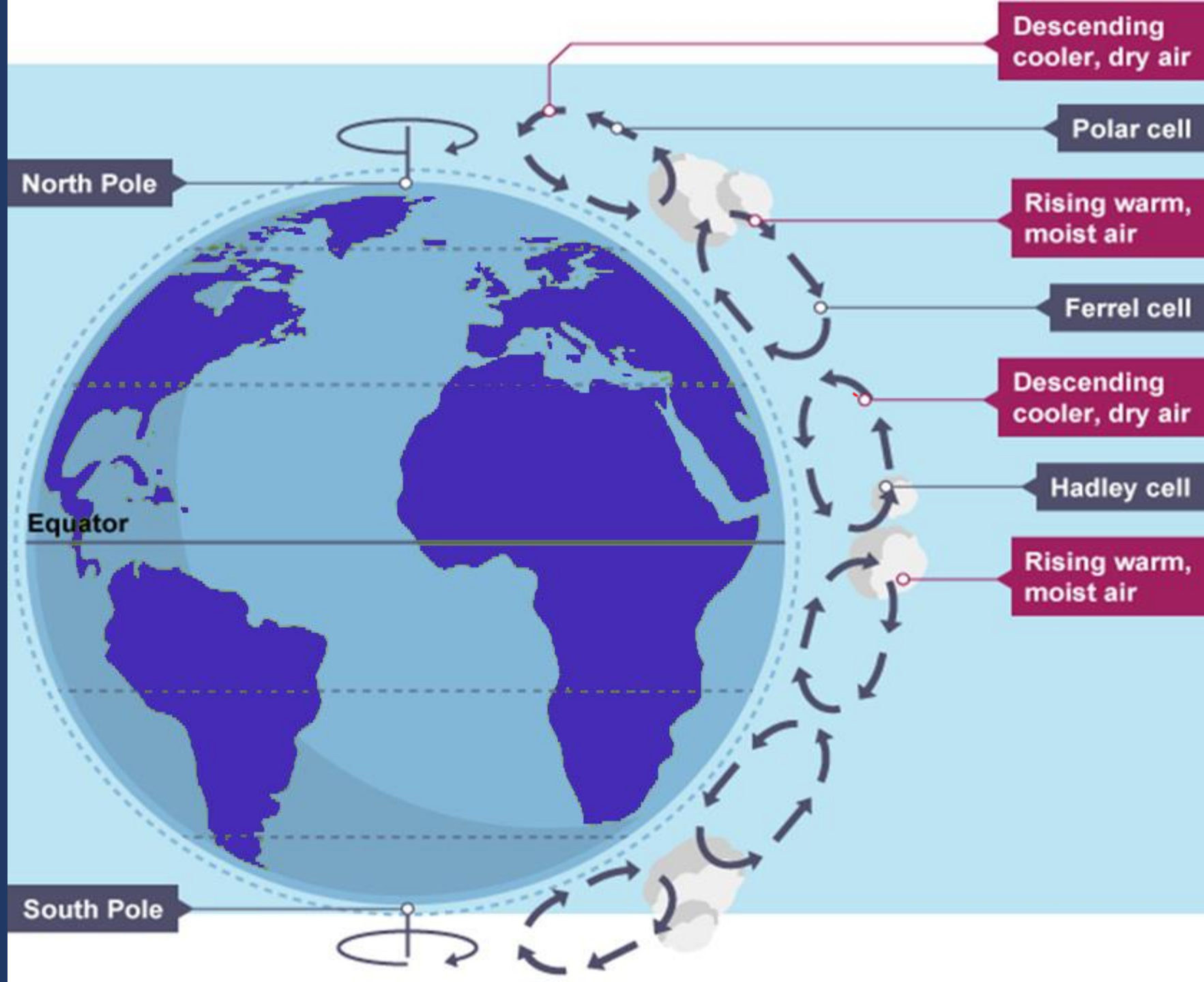
ATMOSPHERIC PRESSURE



GENERAL CIRCULATION OF ATMOSPHERE

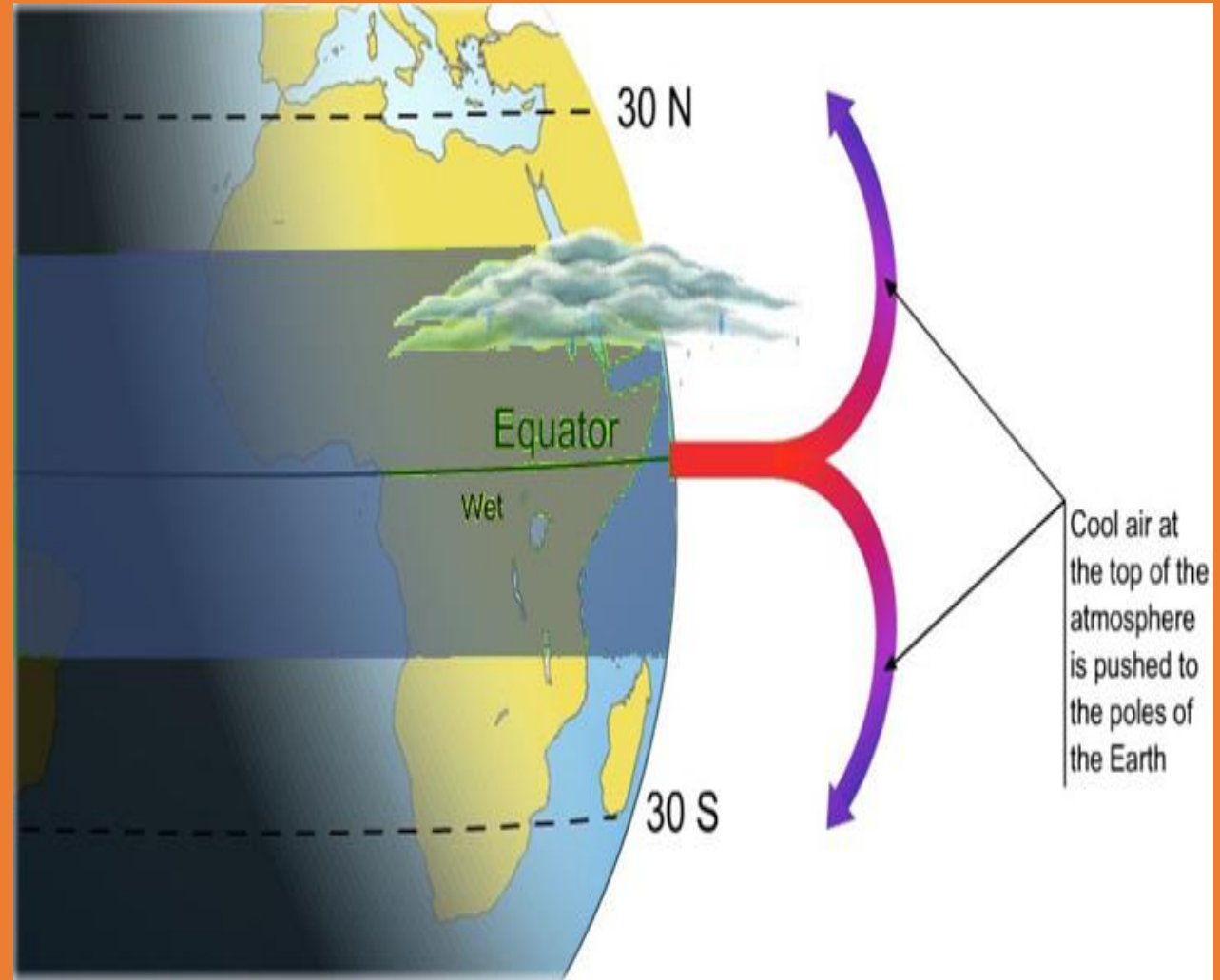
- **ITCZ**
- **Hadley Cell**
- **Ferrell cell**
- **Polar cell**
- **Cloud Formation**





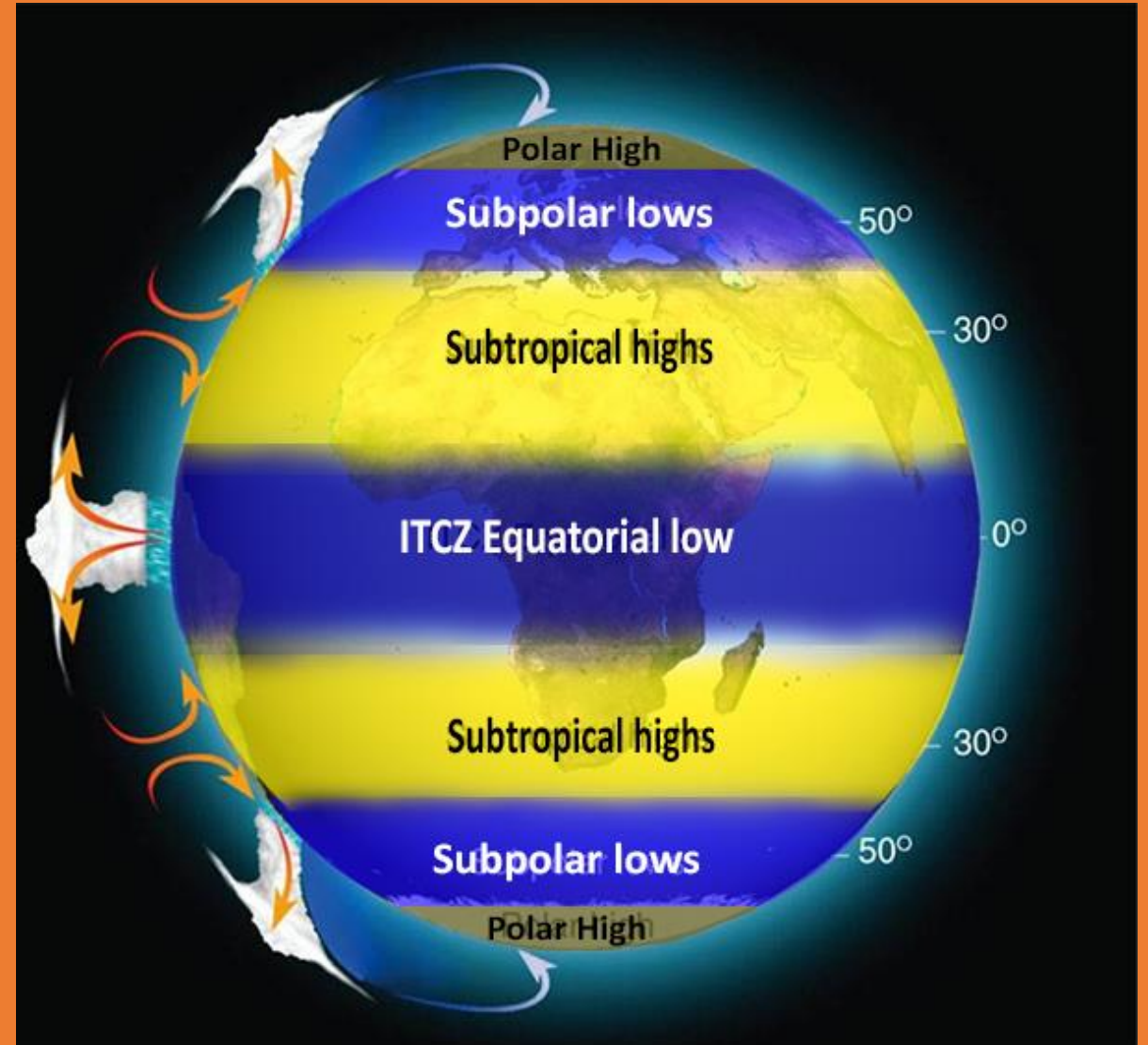
EQUATORIAL LOW

- **Thermally produced low pressure belt**
- **0° - 10° North and South**
- **Pressure is more uniform**
- **Surface winds are generally absent**



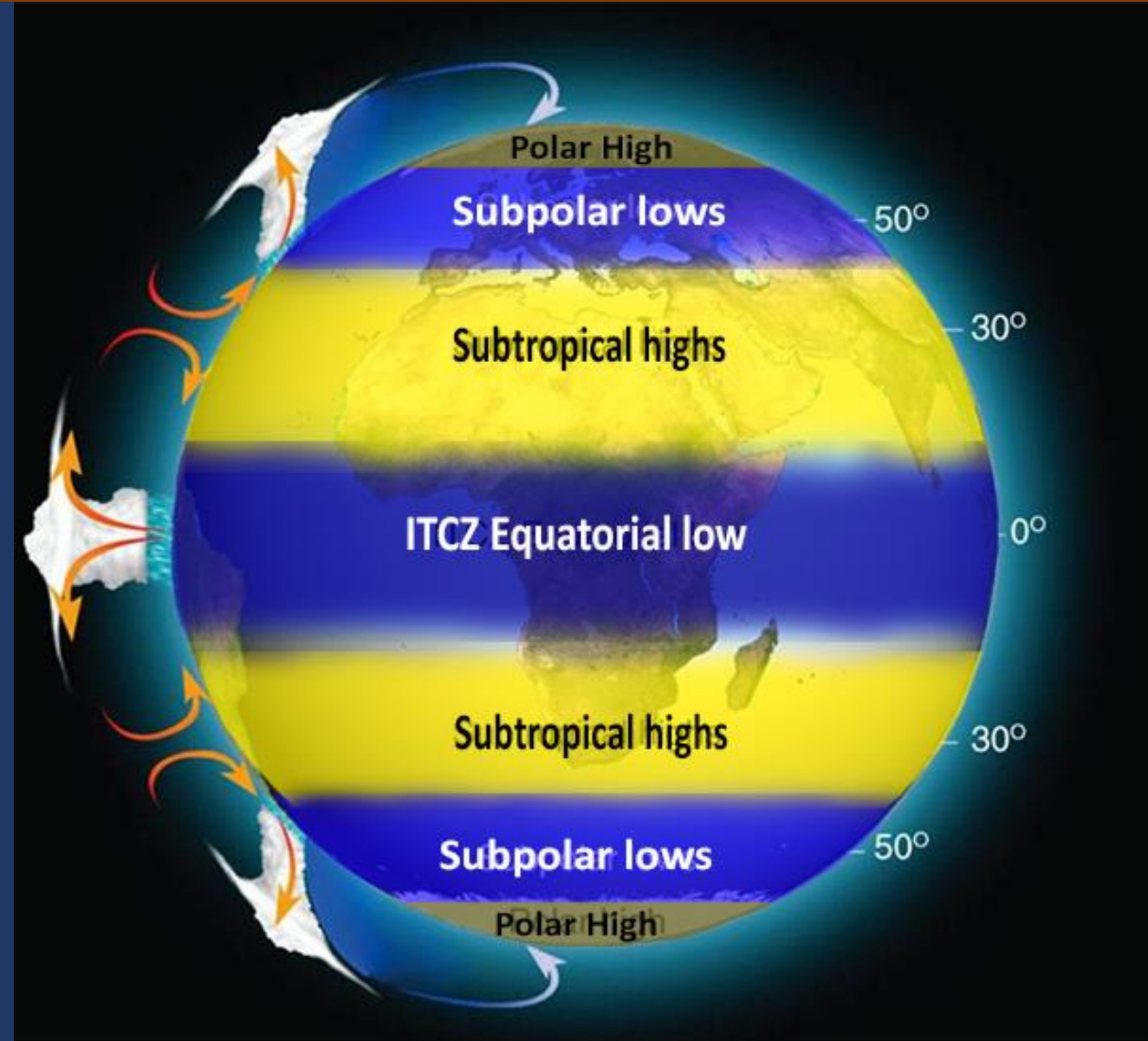
SUBTROPICAL HIGH

- **Subsidence of air**
- **25° - 35° north and south**
- **30°-35° - Horse latitudes**
- **Anticyclonic condition**
- **Aids desert formation**



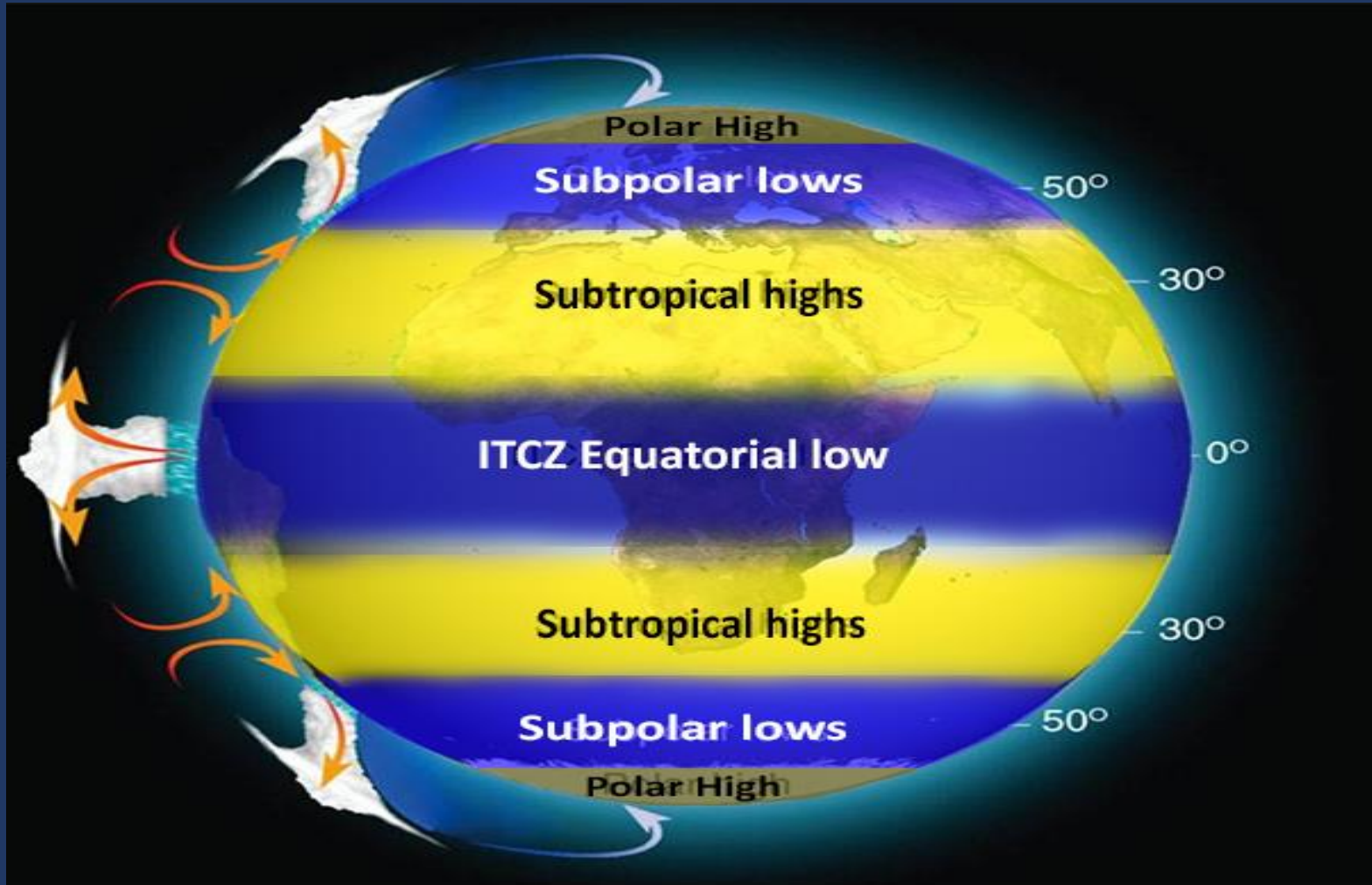
SUBPOLAR LOW

- **45 N and S latitudes to Arctic and Antarctic circles**
- **Converging and rising air**
- **Extra-tropical, Mid-latitude, wave cyclones**



POLAR HIGHS

- **Persistent low temperature**



JANUARY ISOBARS

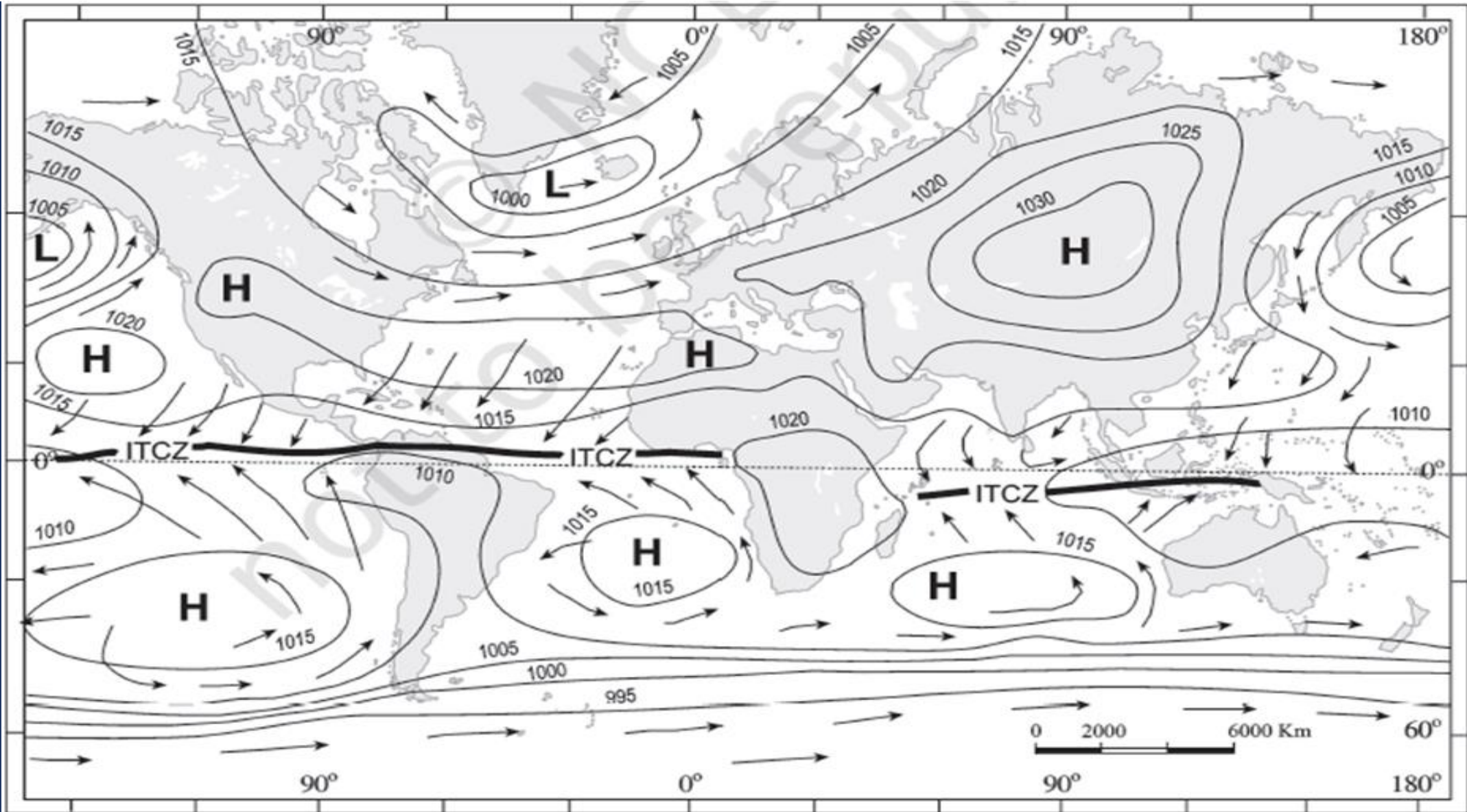


Figure 10.2 : Distribution of pressure (in millibars) — January

JULY ISOBARS

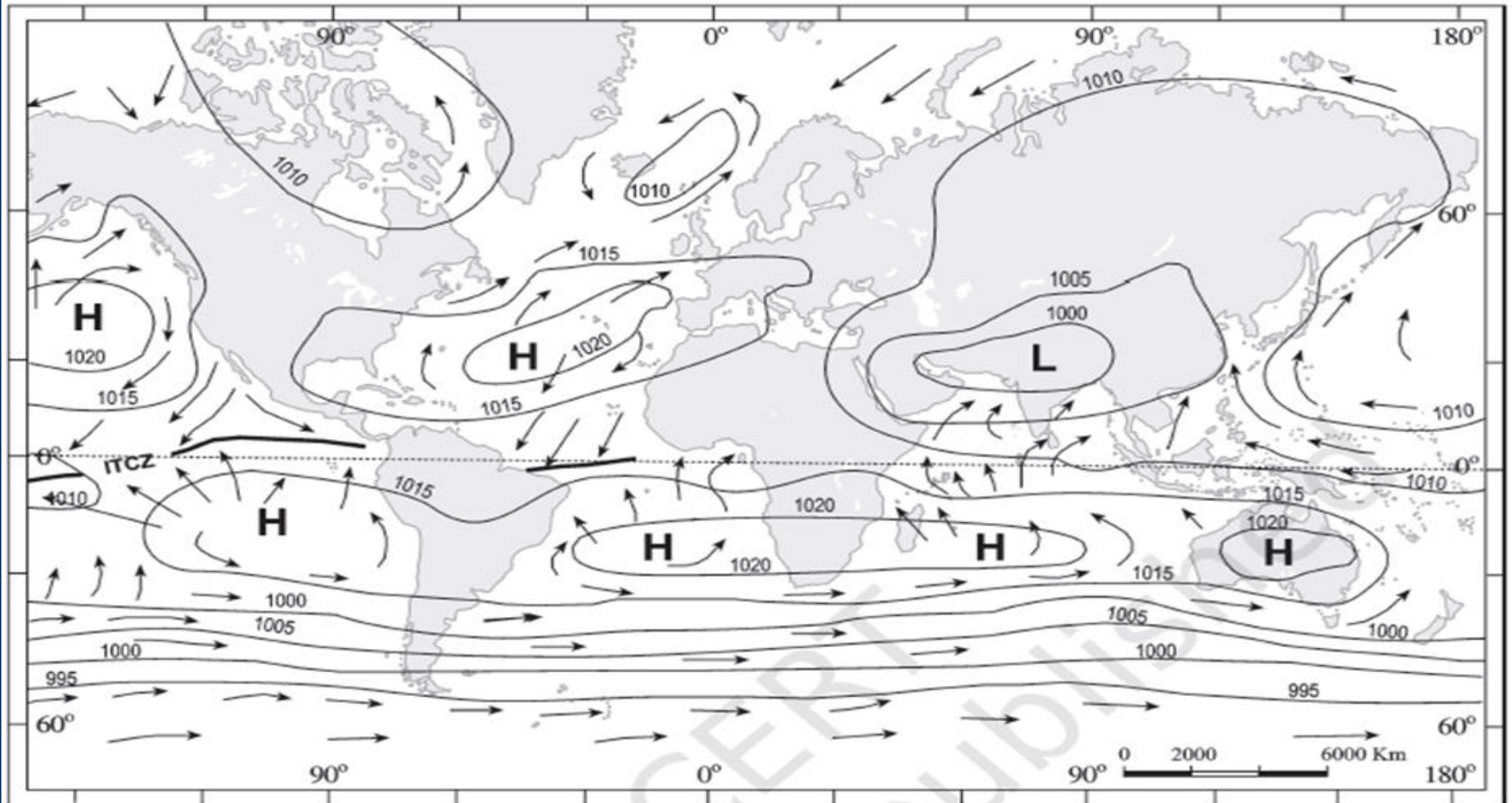


Figure 10.3 : Distribution of pressure (in millibars) — July

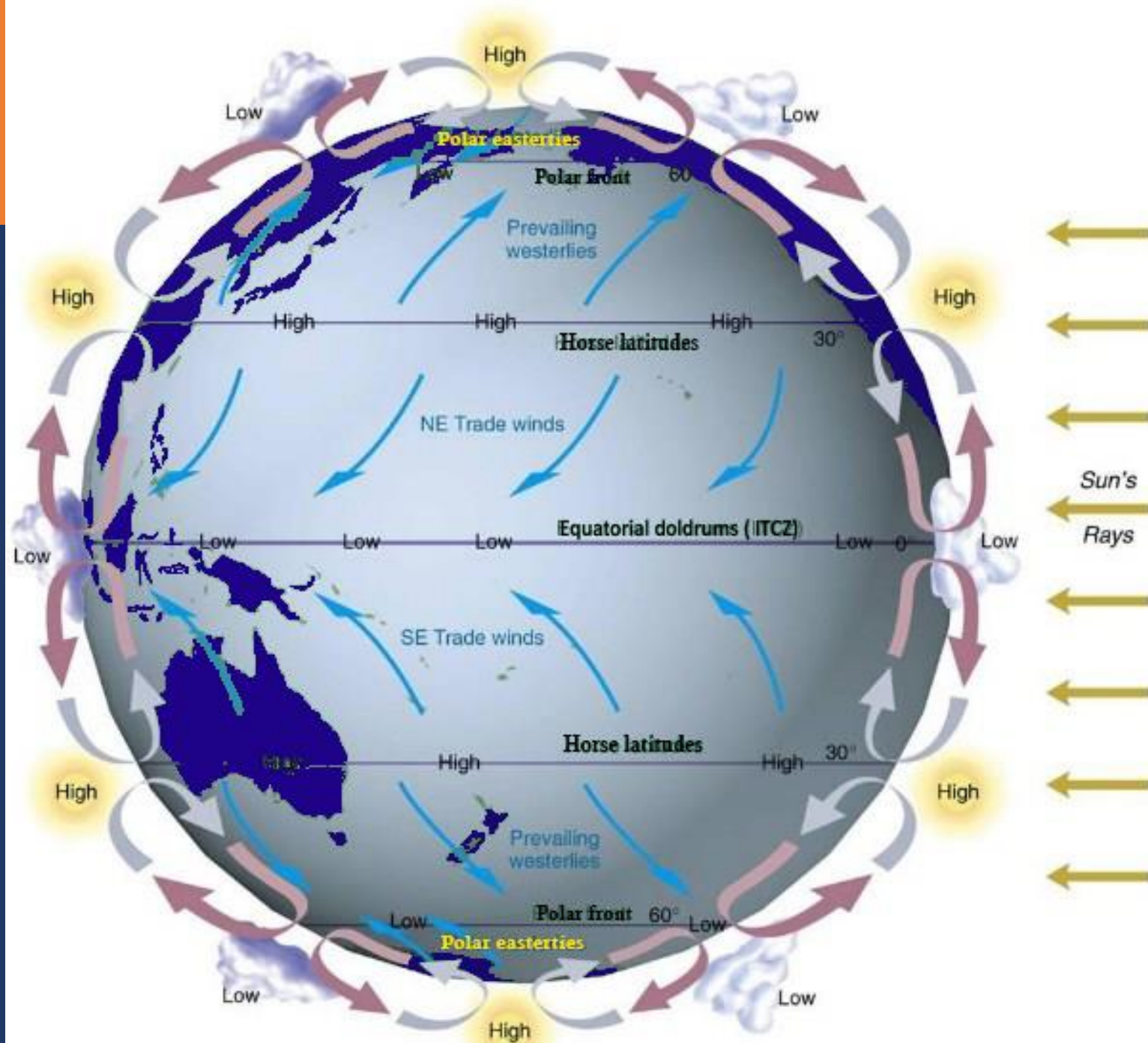
•CLIMATOLOGY



WINDS

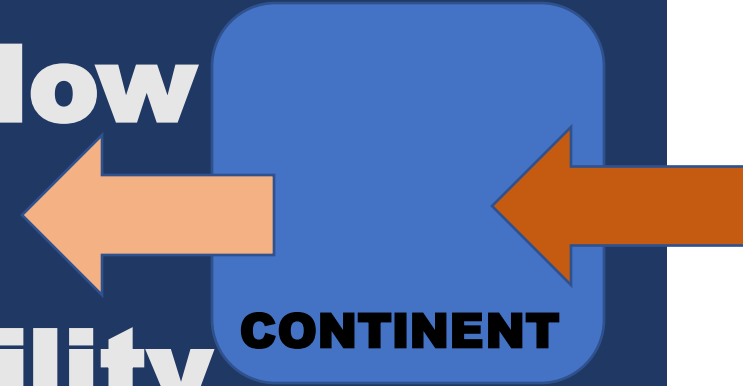
PREVAILING WINDS

- **Doldrums**
- **Trade winds**
- **Westerlies**
- **Polar easterlies**



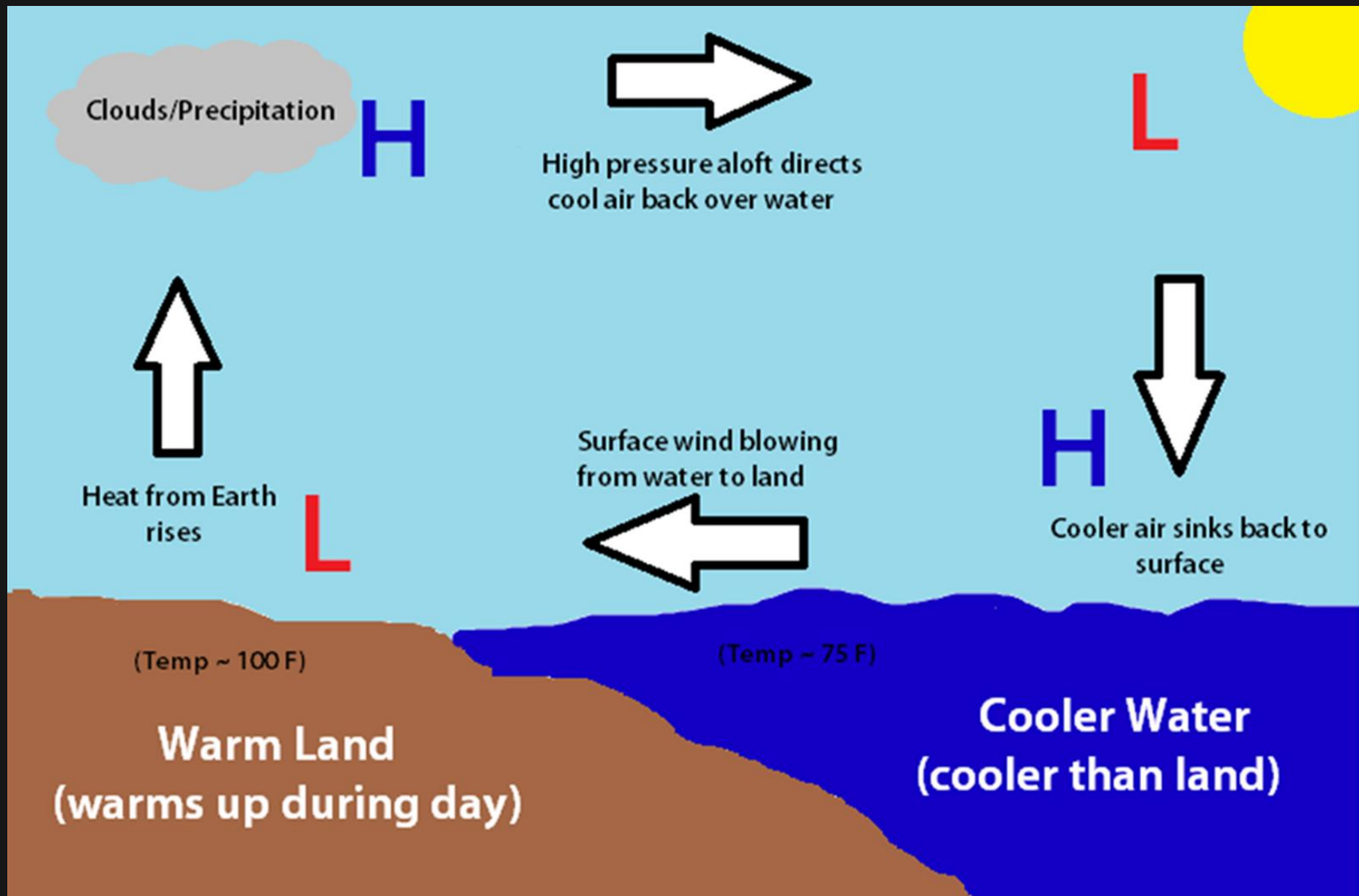
TRADE WINDS

- **10° and 25° north and south latitudes**
- **Sub-tropical high - equatorial low**
- **Steady winds**
- **Beginning – atmospheric stability**
- **Ending – atmospheric instability**
- **Onshore – eastern margin of continent**
- **Offshore – western margin of continent**

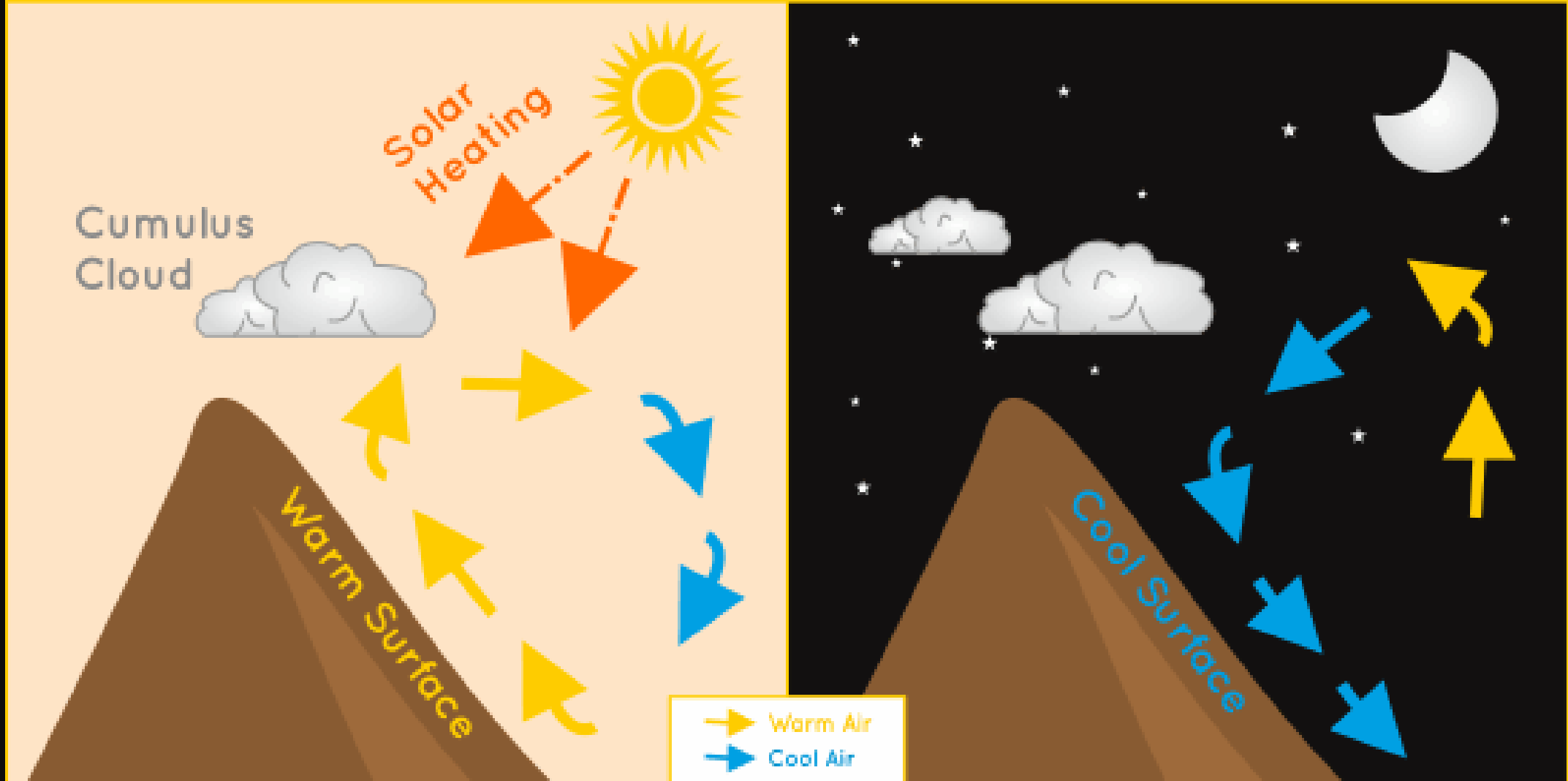


WESTERLIES

- **35° and 60° north and south latitudes**
- **Sub-tropical high - subpolar low**
- **Violent and variable in direction**
- **Seasonal change in strength**
- **Westerlies of the southern hemisphere are stronger**
- **Roaring Forties, Furious Fifties, and Shrieking Sixties**



ANABATIC AND KATABATIC WINDS



Anabatic Winds

Katabatic Winds

Distribution of Local Winds Over the Globe



Tertiary or Local Winds

- Local differences of temperature and pressure produce local winds.
- Such winds are local in extent and are confined to the lowest levels of the troposphere. Some examples of local winds are discussed below.

Loo

- In the plains of northern India and Pakistan, sometimes a very hot and dry wind blows from the west in **May and June**, usually in the afternoons. It is known as **loo**.
- Its temperature invariably ranges between **45 °C and 50 °C**. It may cause **sunstroke** to people.

Foehn or Fohn

- Foehn is a **hot wind** of local importance in the **Alps**.
- It is a strong, gusty, dry and warm wind which develops on the leeward side of a mountain range.
- As the windward side takes away whatever moisture there is in the incoming wind in the form of orographic precipitation, the air that descends on the leeward side is dry and warm (**katabatic wind**).
- The temperature of the wind varies between 15°C and 20°C.
- The wind **helps animal grazing** by melting snow and **aids the ripening of grapes**.

Mistral

- Mistral is one of the local names given to such winds that blow from the Alps over France towards the Mediterranean Sea.
- It is channelled through the Rhone valley. It is **very cold and dry with a high speed**.
- It brings blizzards into southern France.

Chinook

- Chinooks are foehn like winds in **USA and Canada** move down the west slopes of the **Rockies**.
- It is **beneficial to ranchers** east of the Rockies as it keeps the grasslands clear of snow during much of the winter

Sirocco

- Sirocco is a **Mediterranean wind** that comes from the **Sahara** and reaches hurricane speeds in North Africa and Southern Europe.
- It arises from a warm, dry, tropical air mass that is pulled northward by low-pressure cells moving eastward across the Mediterranean Sea, with the wind originating in the **Arabian or Sahara deserts**.
- The hotter, drier continental air mixes with the cooler, wetter air of the maritime cyclone, and the counterclockwise circulation of the low propels the mixed air across the southern coasts of Europe.
- The Sirocco causes dusty dry conditions along the northern coast of Africa, storms in the Mediterranean Sea, and cool, wet weather in Europe.

Loo	Hot	Harmful	Plains of northern India and Pakistan
Mistral	Cold	Harmful	Rhine valley – Southern France
Sirocco	Hot	Harmful	Mediterranean wind that comes from the Sahara
Fohn	Hot	Beneficial	Leeward side of Alps
Chinook	Hot	Beneficial	Leeward side of Rockies

Sl no.	Name	Nature of Wind	Place
1.	Chinook(Snow Eaters)	Hot, Dry wind	The Rockies mountains
1.	Foehn	Hot, Dry wind	The Alps
1.	Khamsin	Hot, Dry wind	Egypt
1.	Sirocco	Hot, Moist wind	Sahara to the Mediterranean Sea
1.	Solano	Hot, Moist wind	Sahara to the Iberian Peninsula
1.	Harmattan(Guineadoctor)	Hot, Dry wind	West Africa
1.	Bora	Cold, Dry wind	Blows from Hungary to North Italy
1.	Mistral	Cold wind	The Alps and France
1.	Punas	Cold, Dry wind	Western side of Andes Mountain
1.	Blizzard	Cold wind	Tundra region
1.	Purga	Cold wind	Russia
1.	Levanter	Cold wind	Spain
1.	Norwester	Hot wind	New Zealand
1.	Santa Ana	Hot wind	South California
1.	Karaburun(Black Storm)	Hot dusty wind	Central Asia
1.	Calima	Dust laden Dry wind	Saharan Air Layer across the Canary Islands
1.	Elephanta	Moist winter in Monsoon	Malabar coast
1.	Gibli	Hot, Dry wind	Libya
1.	Loo	Hot, Dry wind	Satluj- Ganga plains of North India



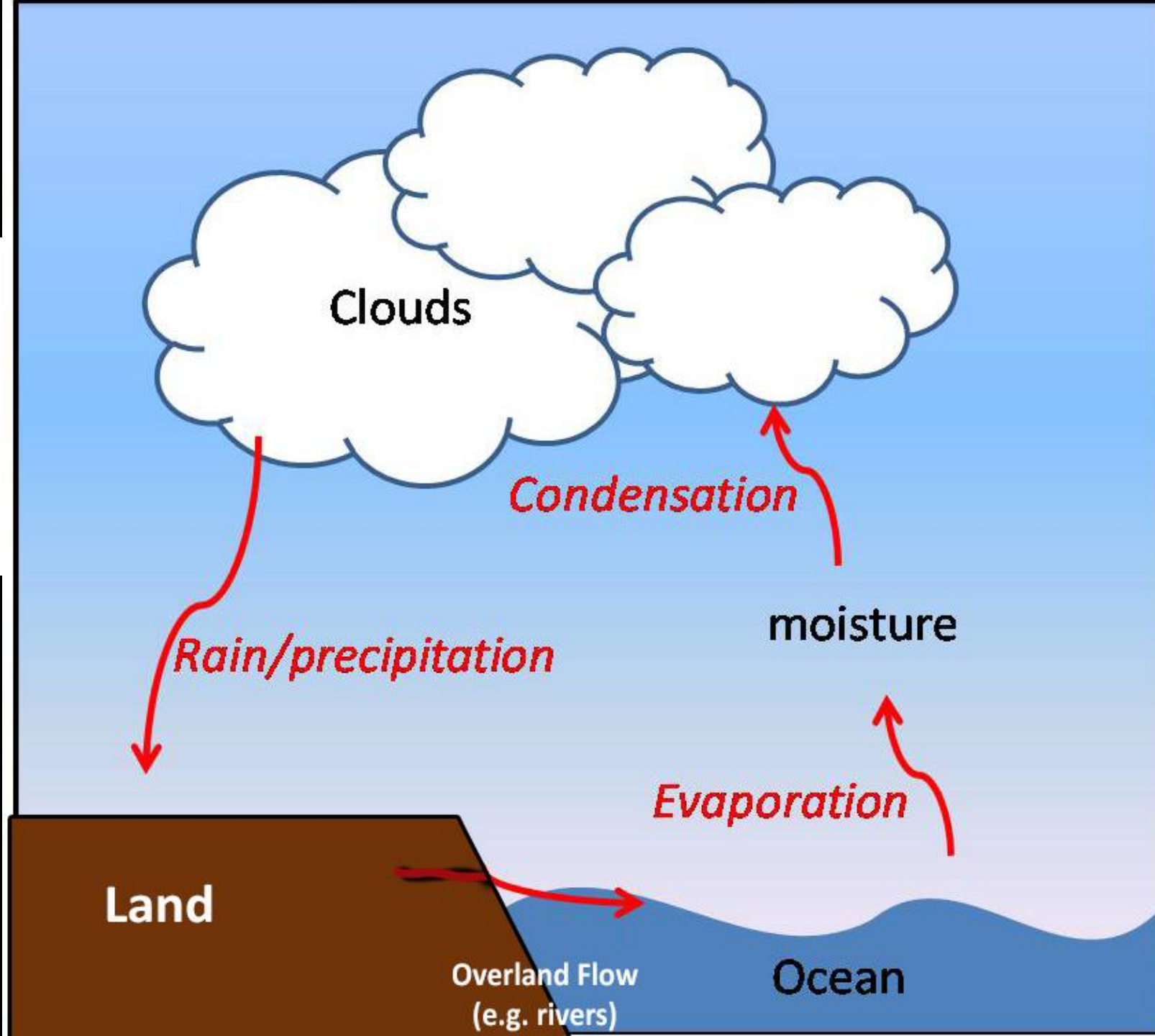
ATMOSPHERIC MOISTURE – PART 1

What is
moisture?

Humidity

Absolute Humidity

Relative Humidity



DEW

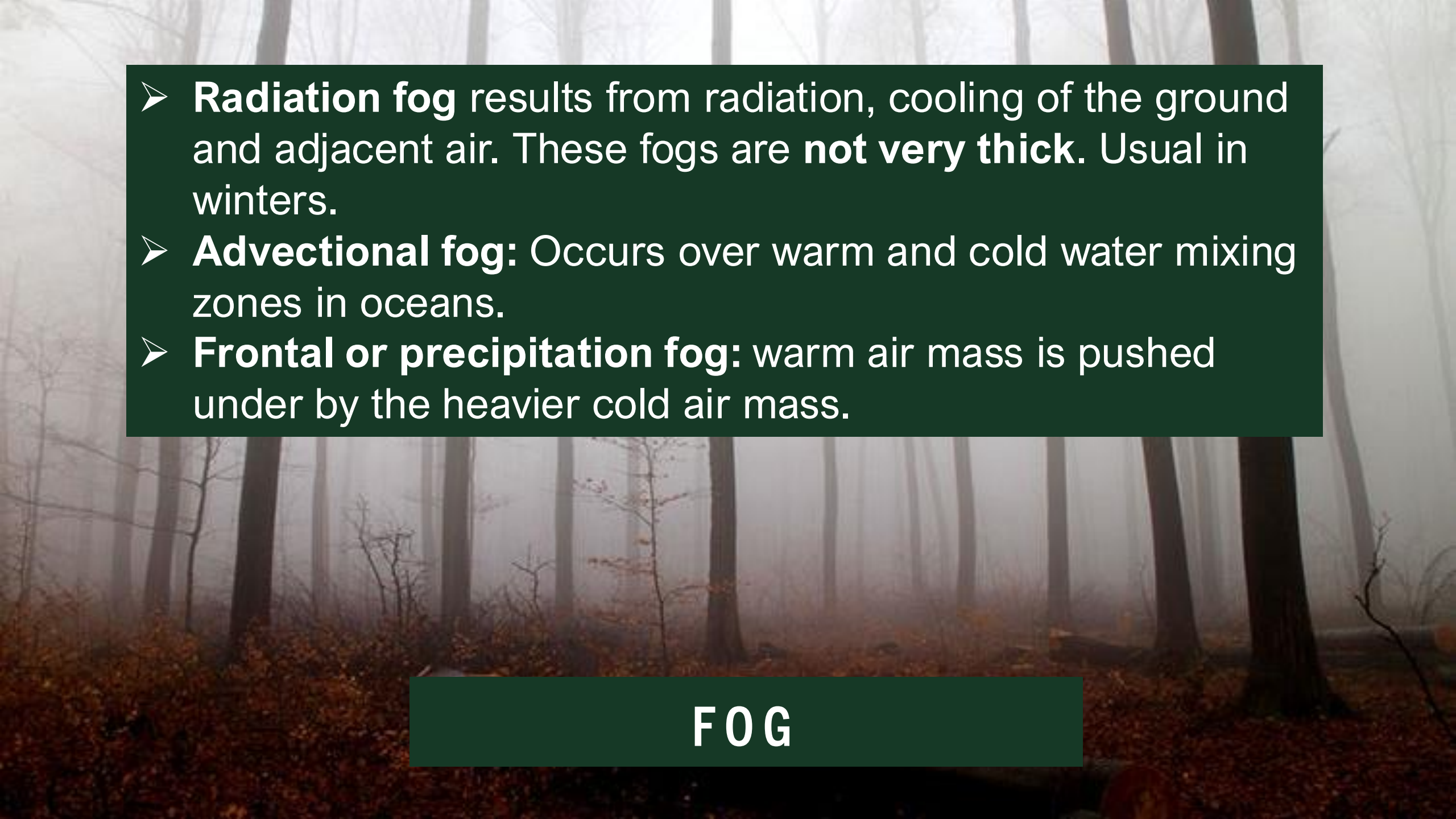
- ❖ **Forms in clear sky, calm air, high relative humidity, and cold and long nights.**
- ❖ **Dew point is above the freezing point.**





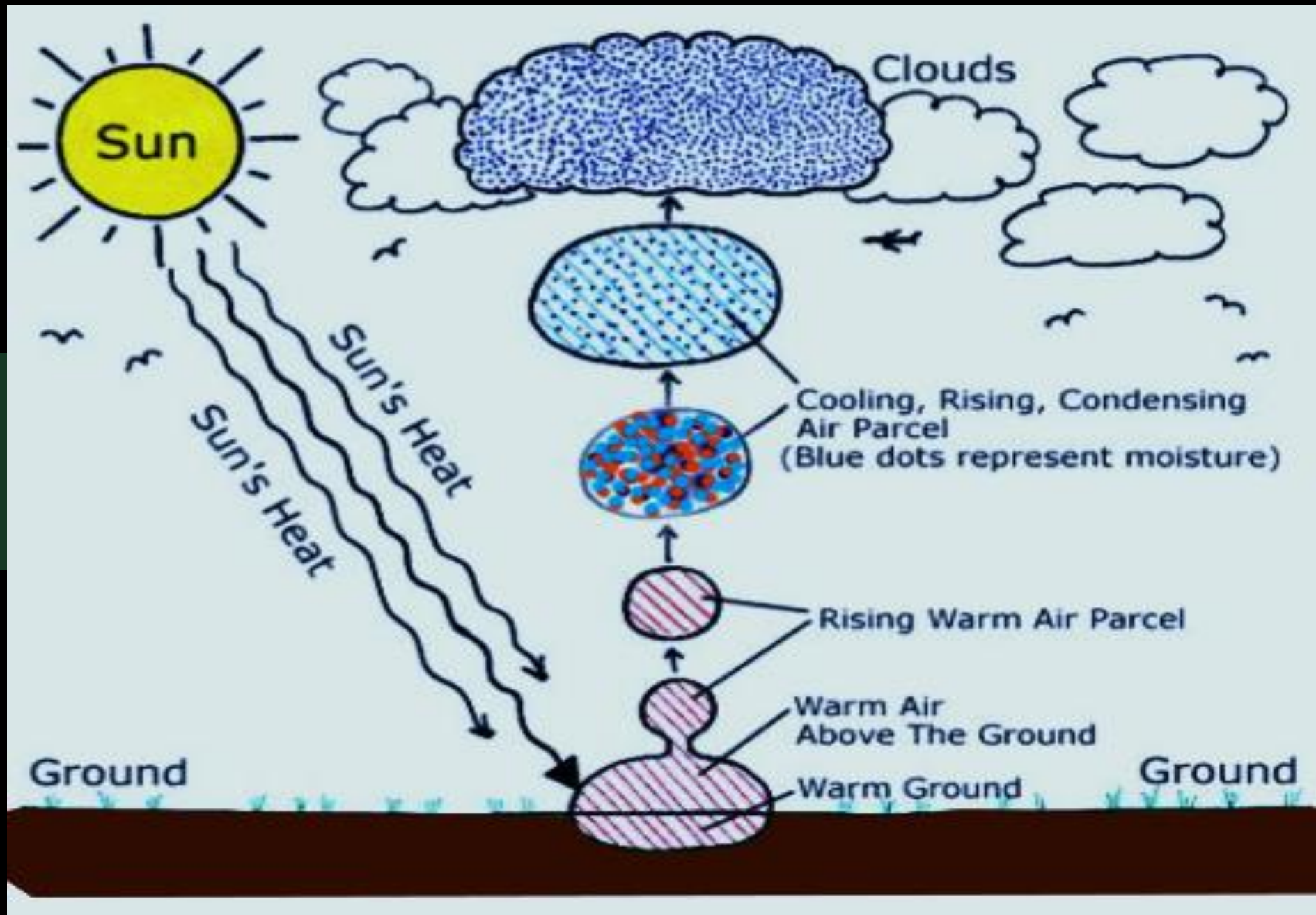
FROST

- Below freezing point (0°C), i.e. the dew point is at or below the freezing point.
- Minute ice crystals instead of water droplets.
- Air temperature must be at or below the freezing point.

- 
- **Radiation fog** results from radiation, cooling of the ground and adjacent air. These fogs are **not very thick**. Usual in winters.
 - **Advectional fog:** Occurs over warm and cold water mixing zones in oceans.
 - **Frontal or precipitation fog:** warm air mass is pushed under by the heavier cold air mass.

FOG

CLOUD FORMATION



CLIMATOLOGY

ATMOSPHERIC MOISTURE – Part 2

**BASED ON
APPEARANCE**

CIRRUS CLOUDS



- **HIGH, WHITE AND THIN**
- **ICE CRYSTALS**
- **FEATHERY APPEARANCE**

CUMULUS CLOUDS

- **FLAT BASE**
- **RISING DOMES**
- **VERTICAL DEVELOPMENT**
- **FAIR WEATHER**



STRATUS CLOUDS



- **SHEETS OR LAYERS**
- **NO RAINFALL**

NIMBUS CLOUDS

- **DARK GREY**
- **THICK
VAPOUR**
- **LOW
ALTITUDE**



**BASED ON
HEIGHT**

42,500 ft.
13,000m

A cloud is a mass of floating water droplets or ice crystals.

39,000 ft.
12,000m

**High
Clouds**

Cirrus

Cirrocumulus

Cirrostratus

20,000 ft.
6,000m

**Middle
Clouds**

Altostratus

Cumulonimbus

Alto cumulus

6,500 ft.
2,000m

**Low
Clouds**

Stratocumulus

Cumulus

Stratus

Nimbostratus

HIGH CLOUDS

CIRRUS

- FAIR WEATHER

CIRROSTRATUS

- SHEET OF CLOUD
- HALO

CIRROCUMULUS

- MACKEREL SKY
- SMALL GLOBULAR
MASSES
- WITHOUT SHADOWS

MIDDLE CLOUDS

ALTOSTRATUS

- SHEET OF CLOUDS
- CORONA
- CONTINUOUS
PRECIPITATION

ALTO CUMULUS

- FLATTENED
GLOBULAR MASS
- SHADOWS

LOW CLOUDS

STRATOCUMULUS

- LARGE GLOBULAR
MASSES

NIMBOSTRATUS

- CONTINUOUS
RAINFALL

CUMULONIMBUS

- GREAT VERTICAL
DEVELOPMENT
- THUNDERSTORMS

HALO FORMATION



CORONA FORMATION



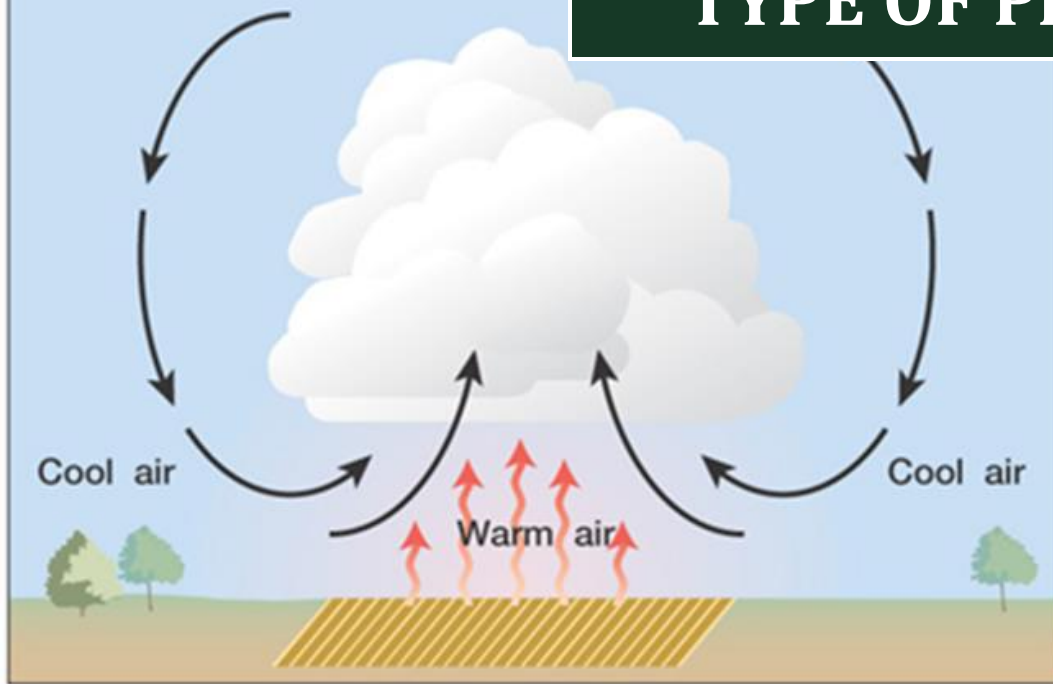
MACKEREL SKY



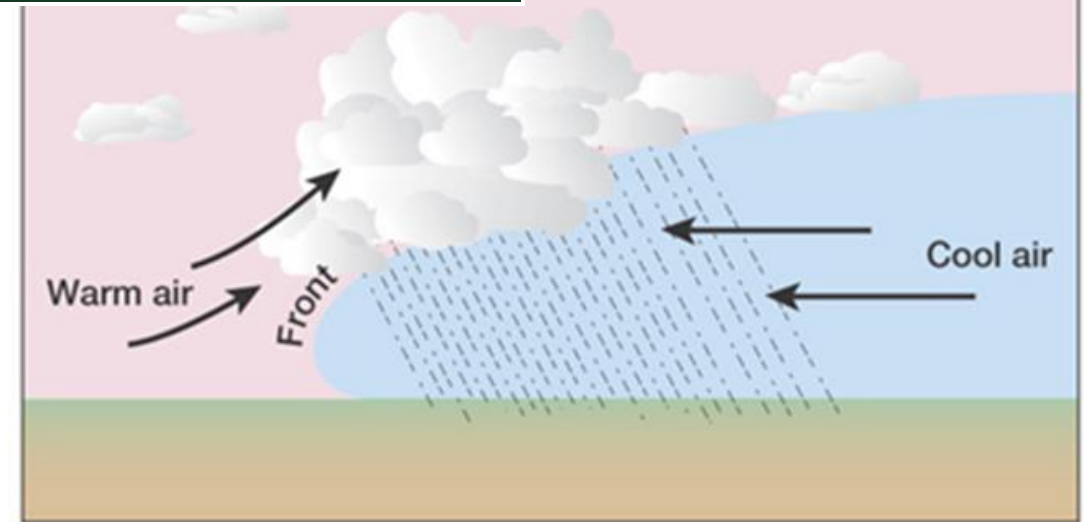
THUNDER CLOUDS



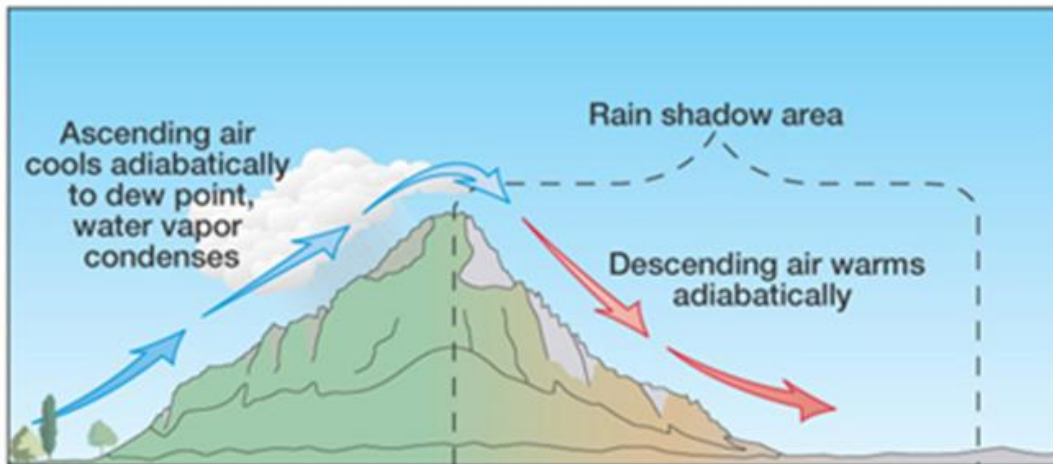
TYPE OF PRECIPITATION



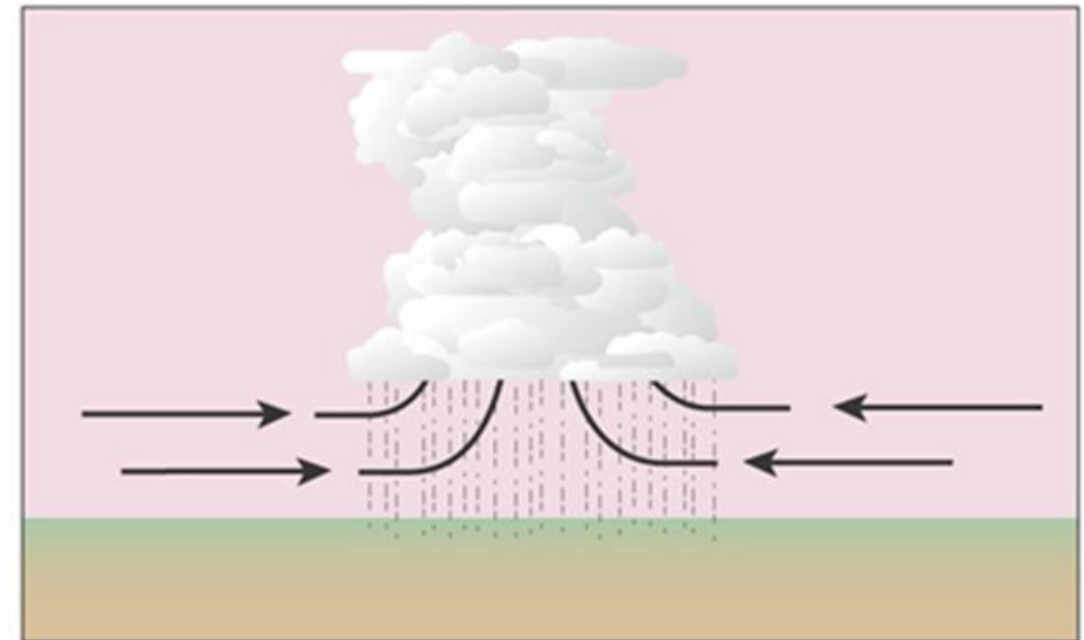
(a) Convective



(c) Frontal



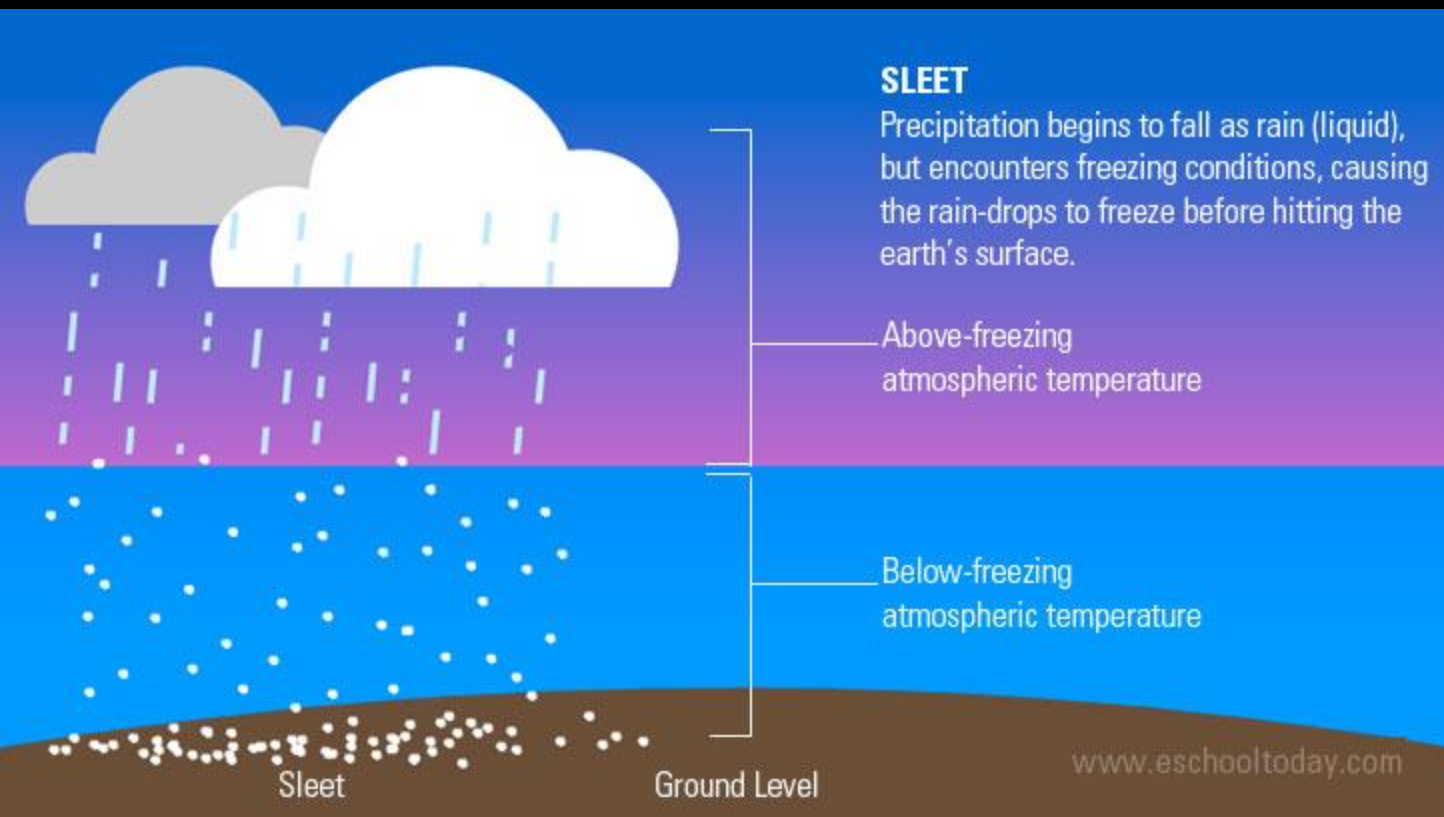
(b) Orographic



(d) Convergent

FORMS OF PRECIPITATION

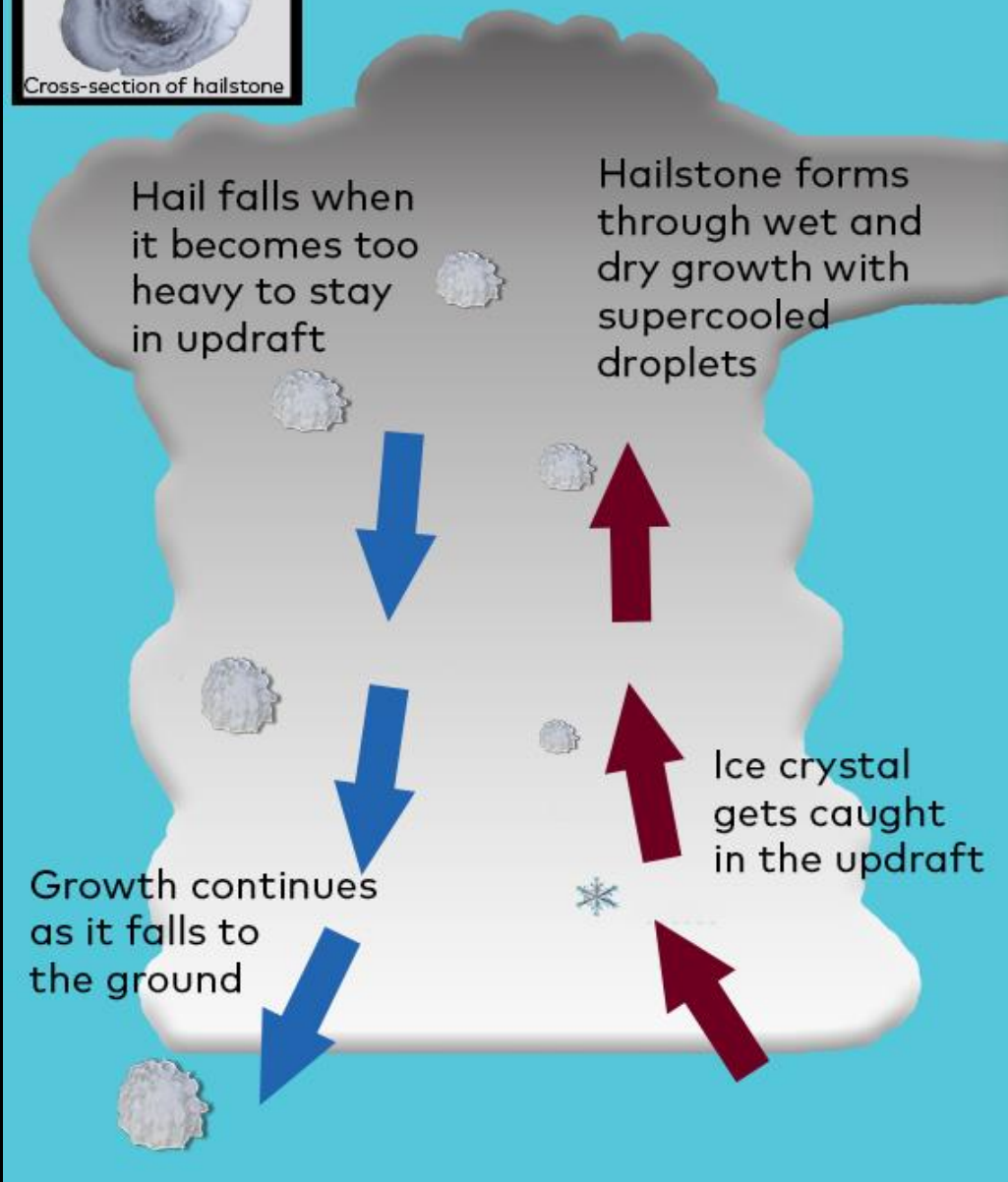






Cross-section of hailstone

Hail Formation



Global Distribution of Precipitation



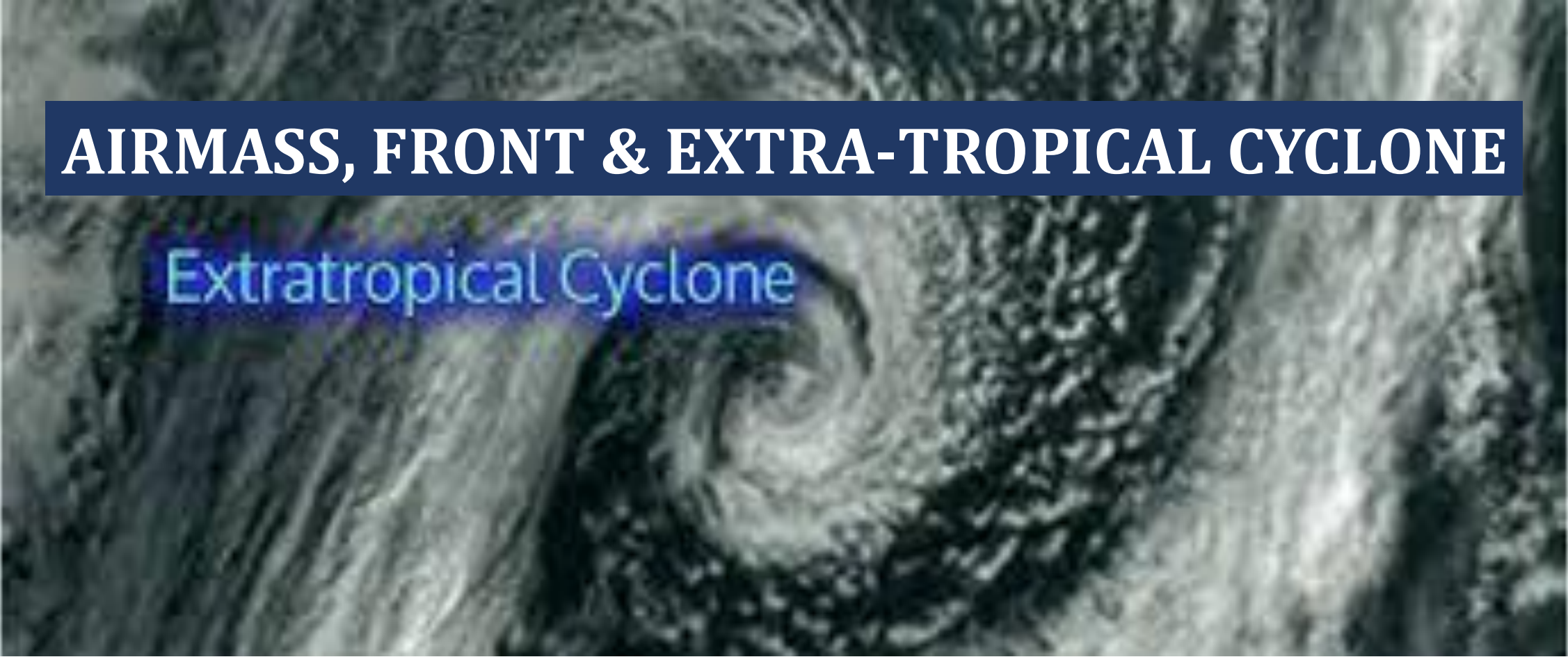
FACTORS OF PRECIPITATION

- **Low Pressure belt receives heavy rainfall**
- **Distance from sea**
- **Low Latitude receives heavy rainfall**
- **Windward and Leeward Side**
- **Trade winds are onshore in the eastern margin**
- **Westerlies are onshore in the western margin**
- **Desert Formation**
- **Ocean Current**

CLIMATOLOGY

AIRMASS, FRONT & EXTRA-TROPICAL CYCLONE

Extratropical Cyclone

A satellite image of an extratropical cyclone, showing a large, swirling cloud system with a distinct eye and spiral bands of clouds. The text "Extratropical Cyclone" is overlaid in blue on the left side of the image.

AIRMASS

- **Little horizontal variation in temperature, moisture and pressure**
- **Homogenous region**
- **Large scale subsidence**

CLASSIFICATION

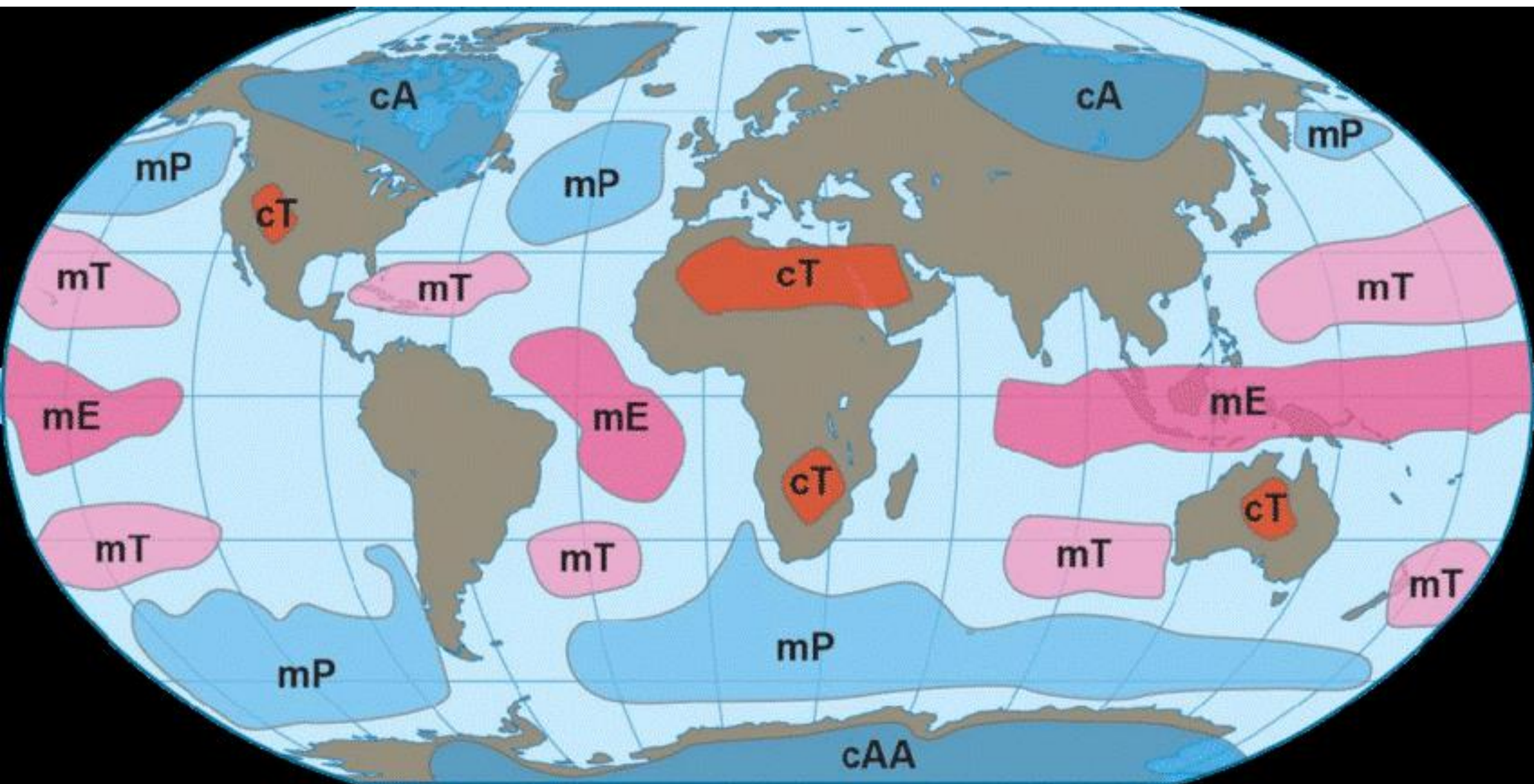
➤ Based on **HUMIDITY**

- **Continental (dry)**
- **Maritime (moist)**

➤ Based on **TEMPERATURE**

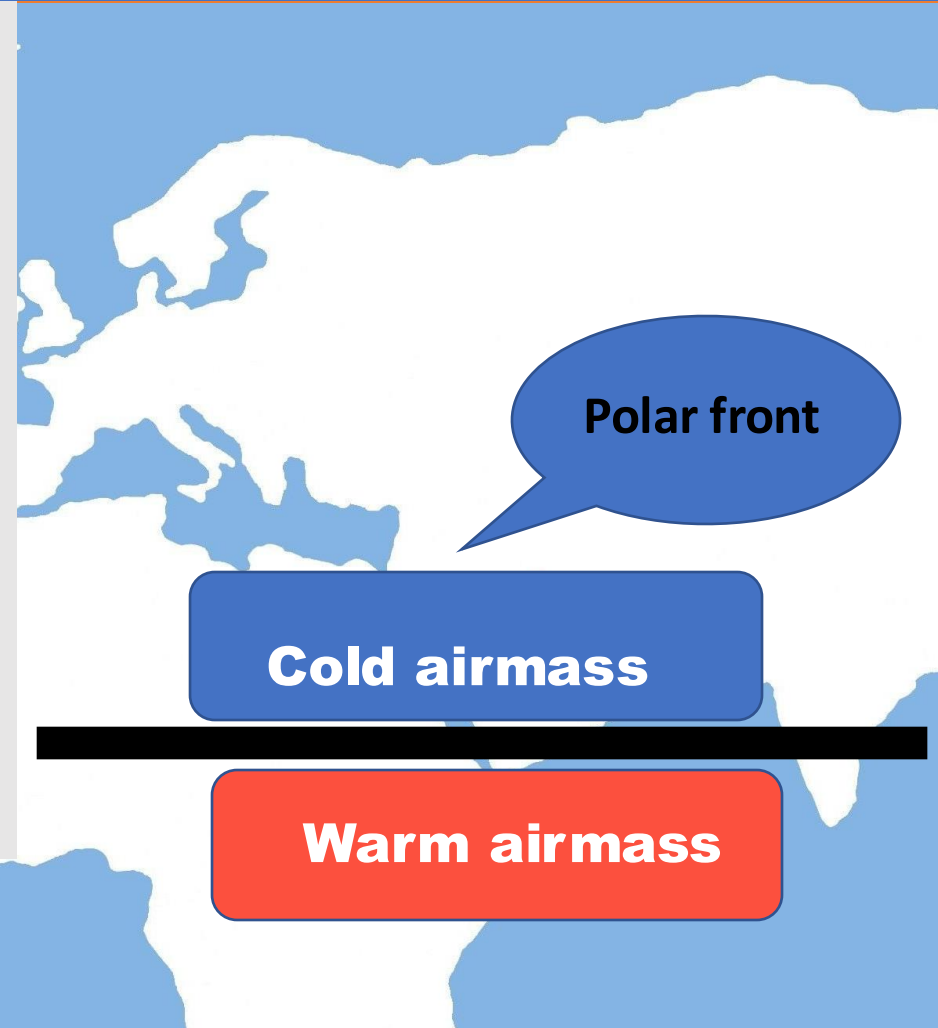
- **Tropical (warm)**
- **Polar (cold)**
- **Arctic (extremely cold)**

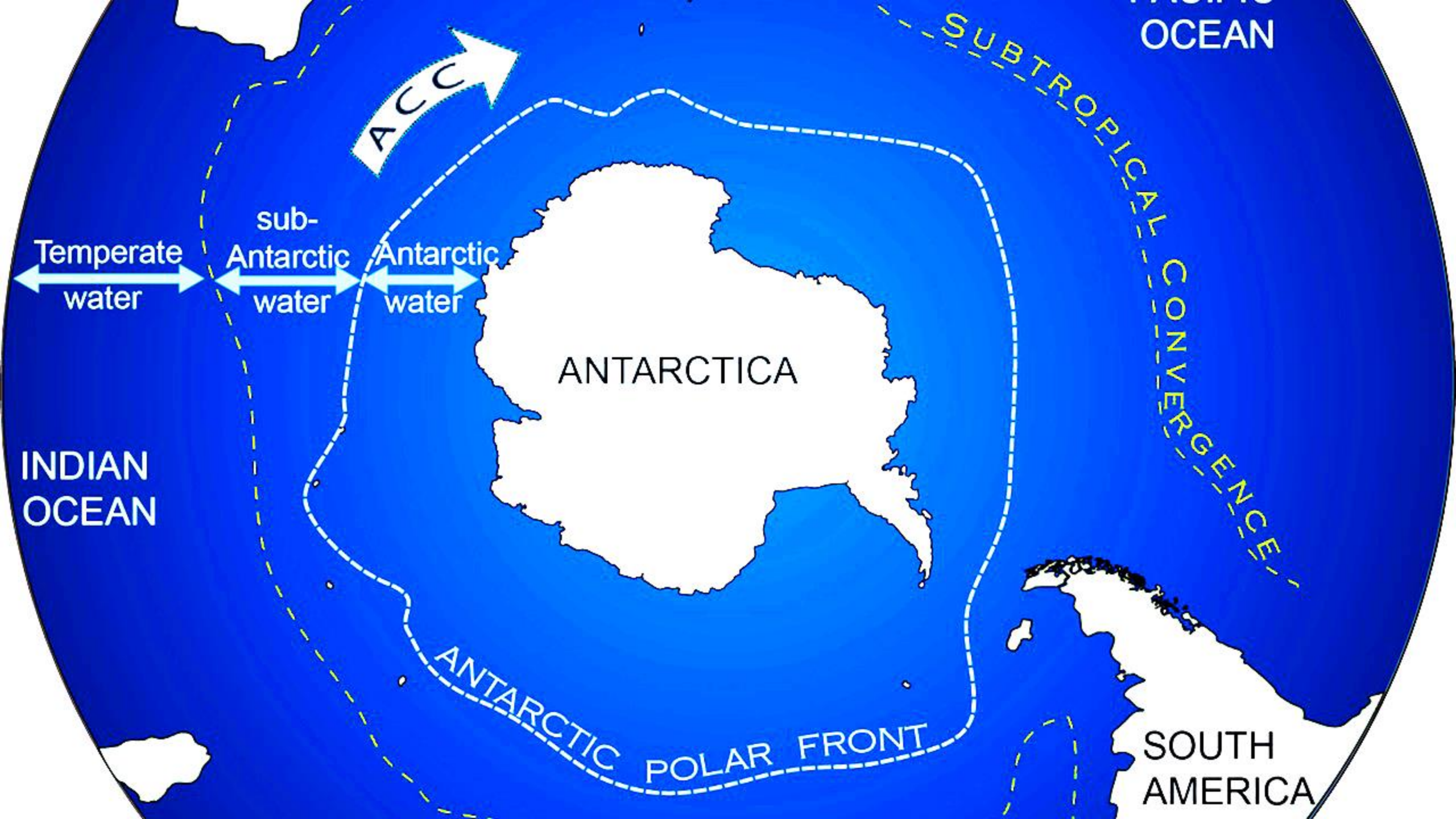
AIR MASSES	SOURCE REGION	CHARACTERISTICS
Continental Arctic (cA)	Greenland, Antarctica, Highest latitudes of Asia and North America	Very cold and very dry, extremely stable, very little cloud cover.
Continental Polar (cP)	High latitudes, continental interiors	Cold and dry, very stable, very little cloud cover
Maritime Polar (mP)	High-latitude oceans	Cold, moist and cloudy, somewhat unstable
Continental Tropics (cT)	Low-latitude deserts	Hot and dry, very unstable
Maritime Tropics (mT)	Subtropical oceans	Warm and humid



FRONTS

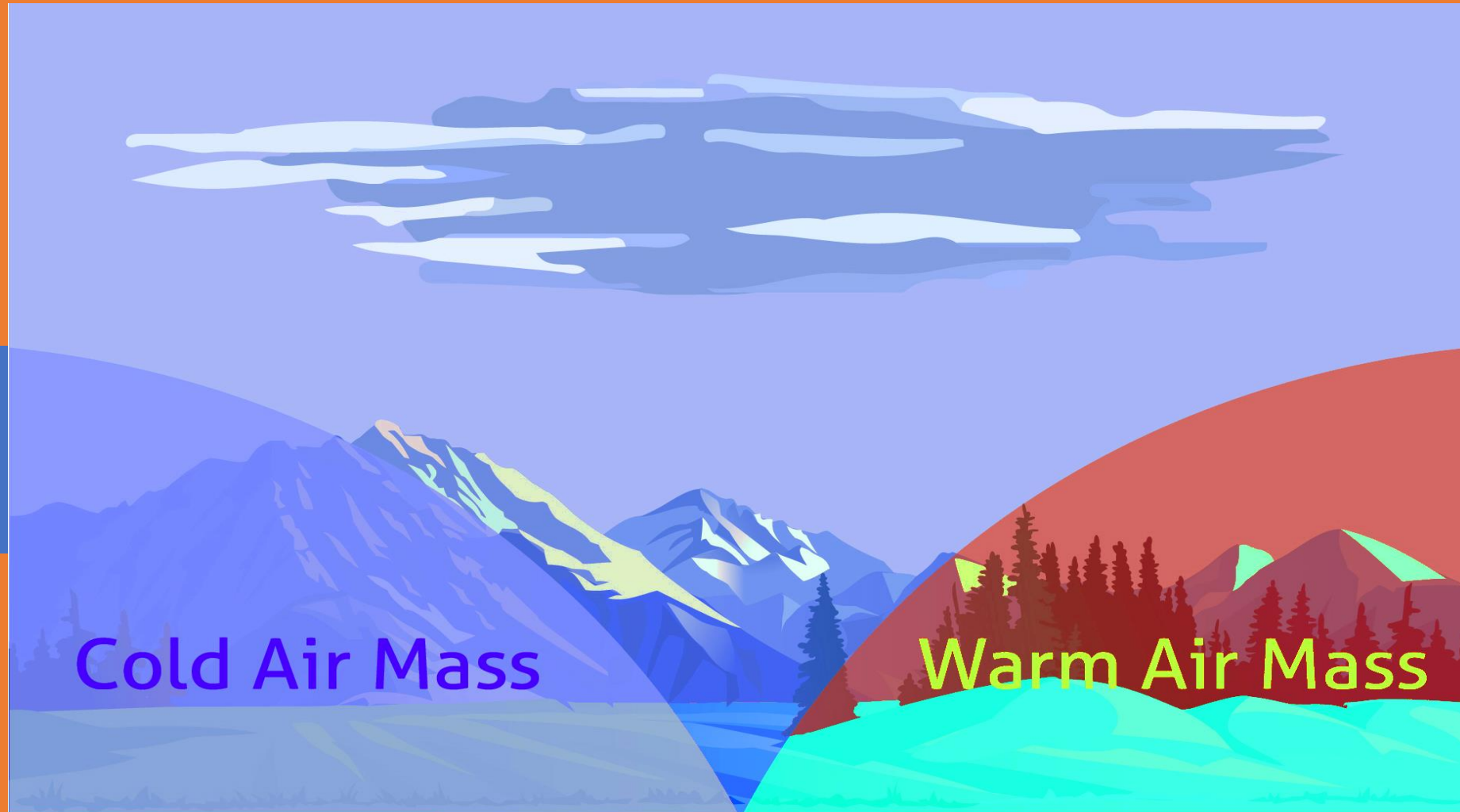
- ❑ Boundary zone of convergence
- ❑ High difference in temperature and pressure
- ❑ Polar front





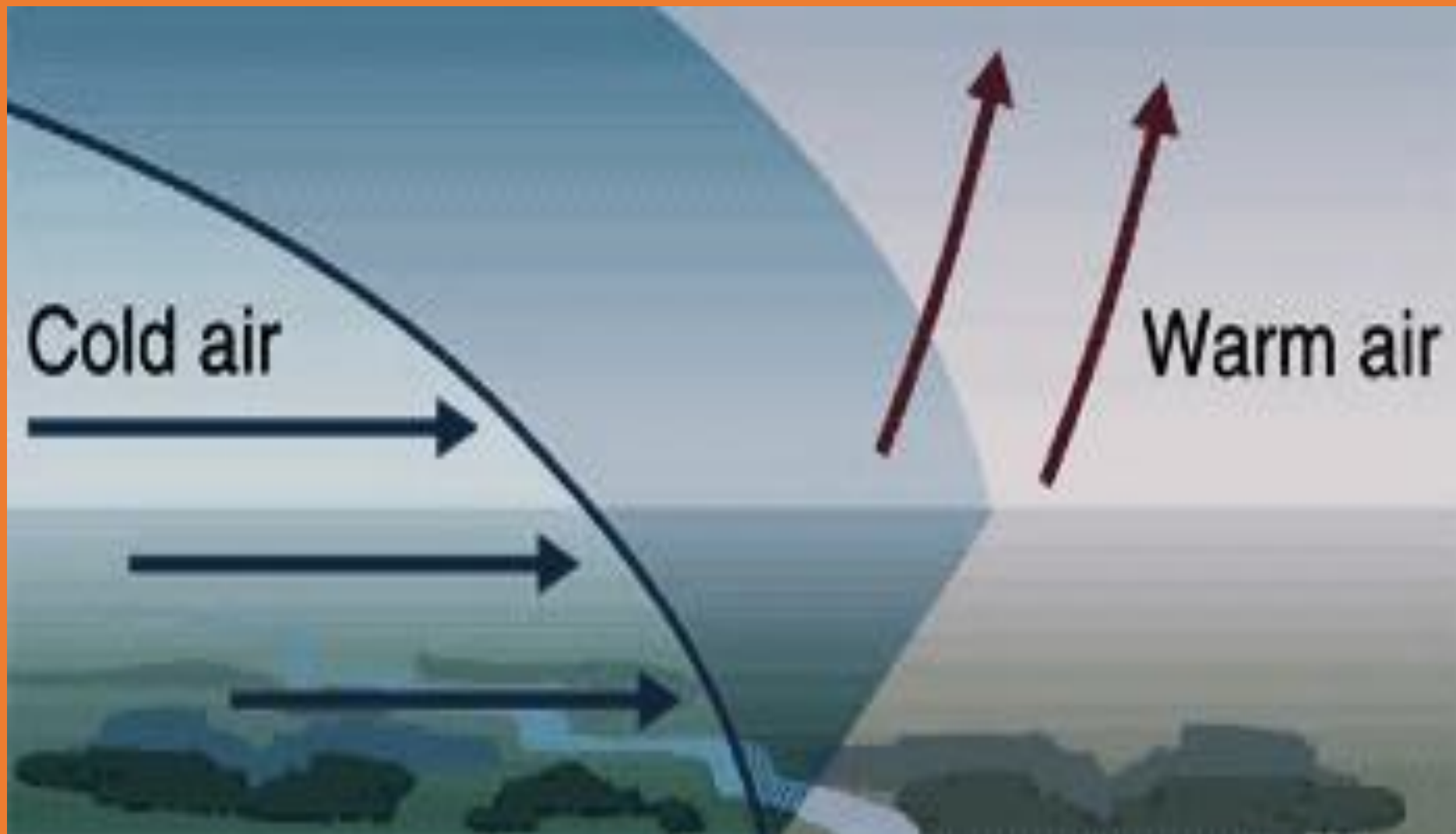
CLASSIFICATION

STATIONARY FRONT



CLASSIFICATION

COLD FRONT

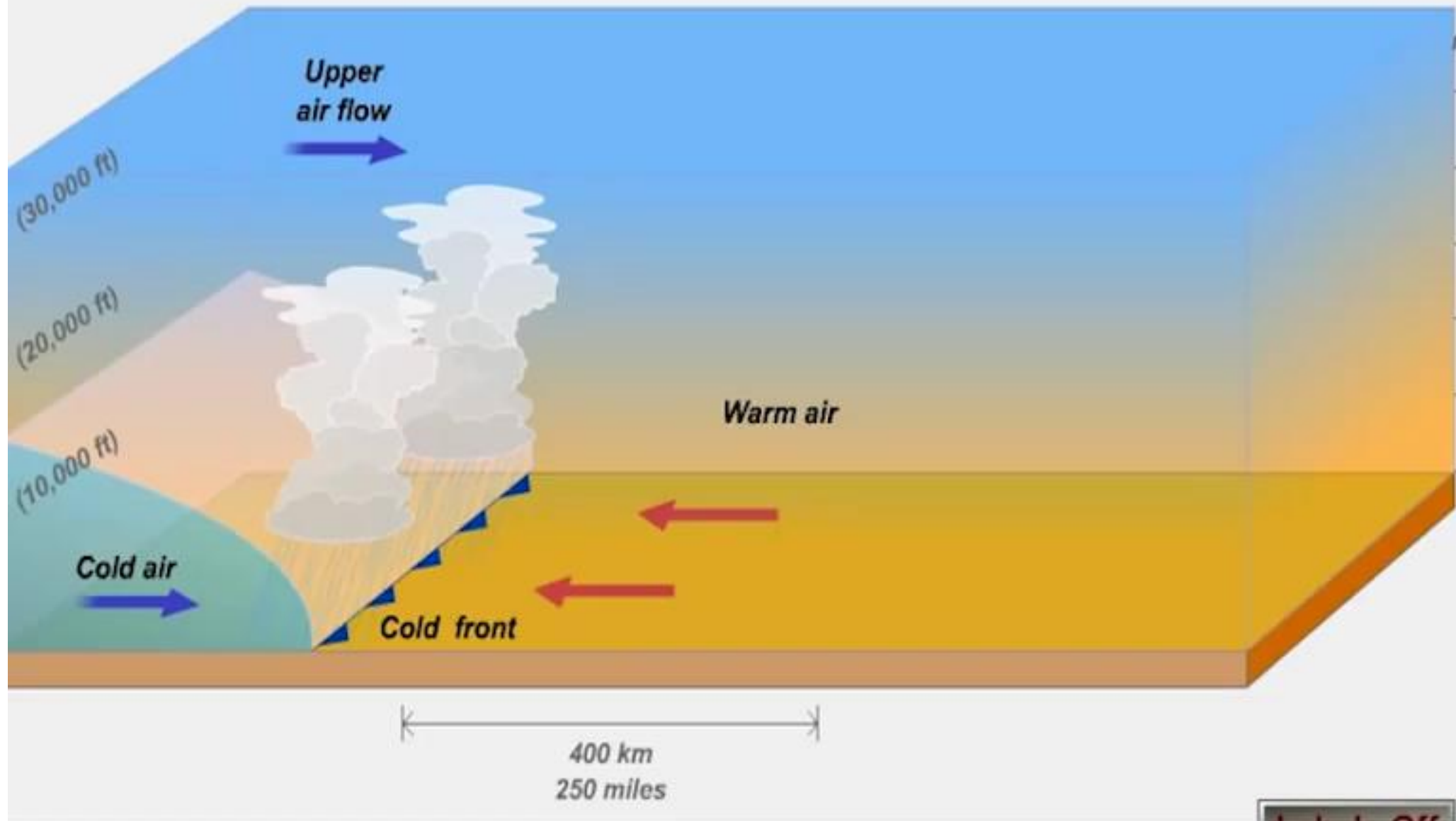


CLASSIFICATION

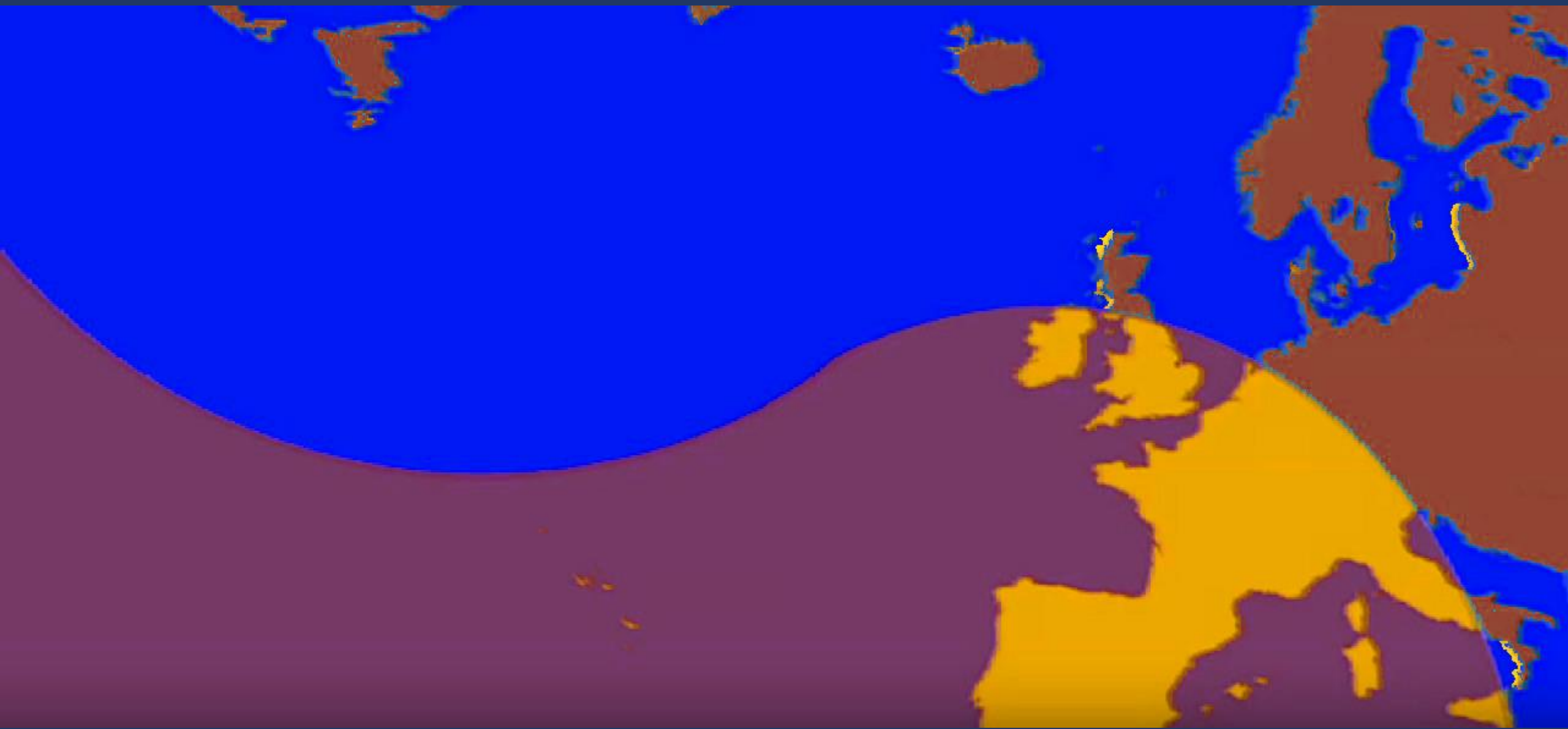
WARM FRONT



Cold Front

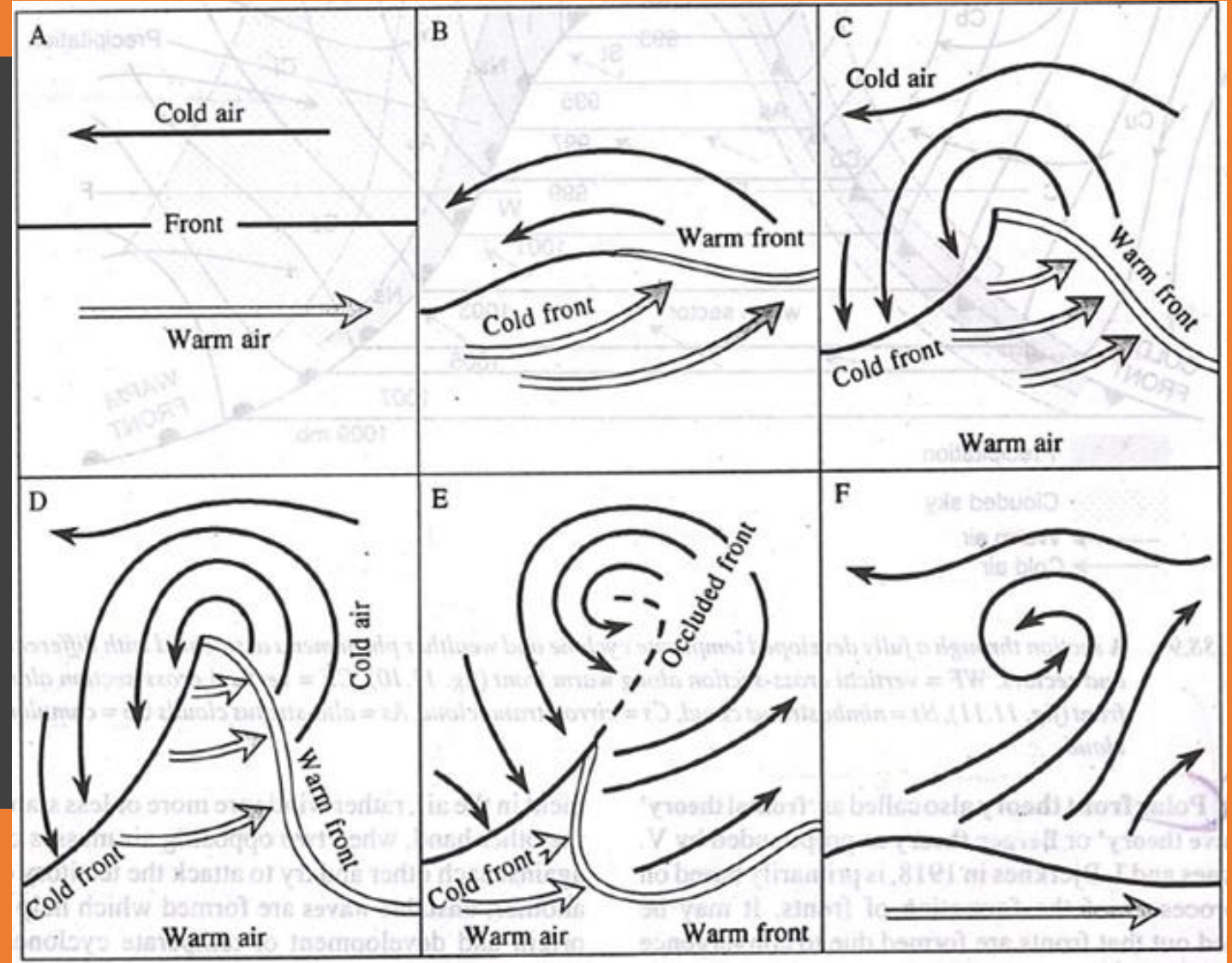


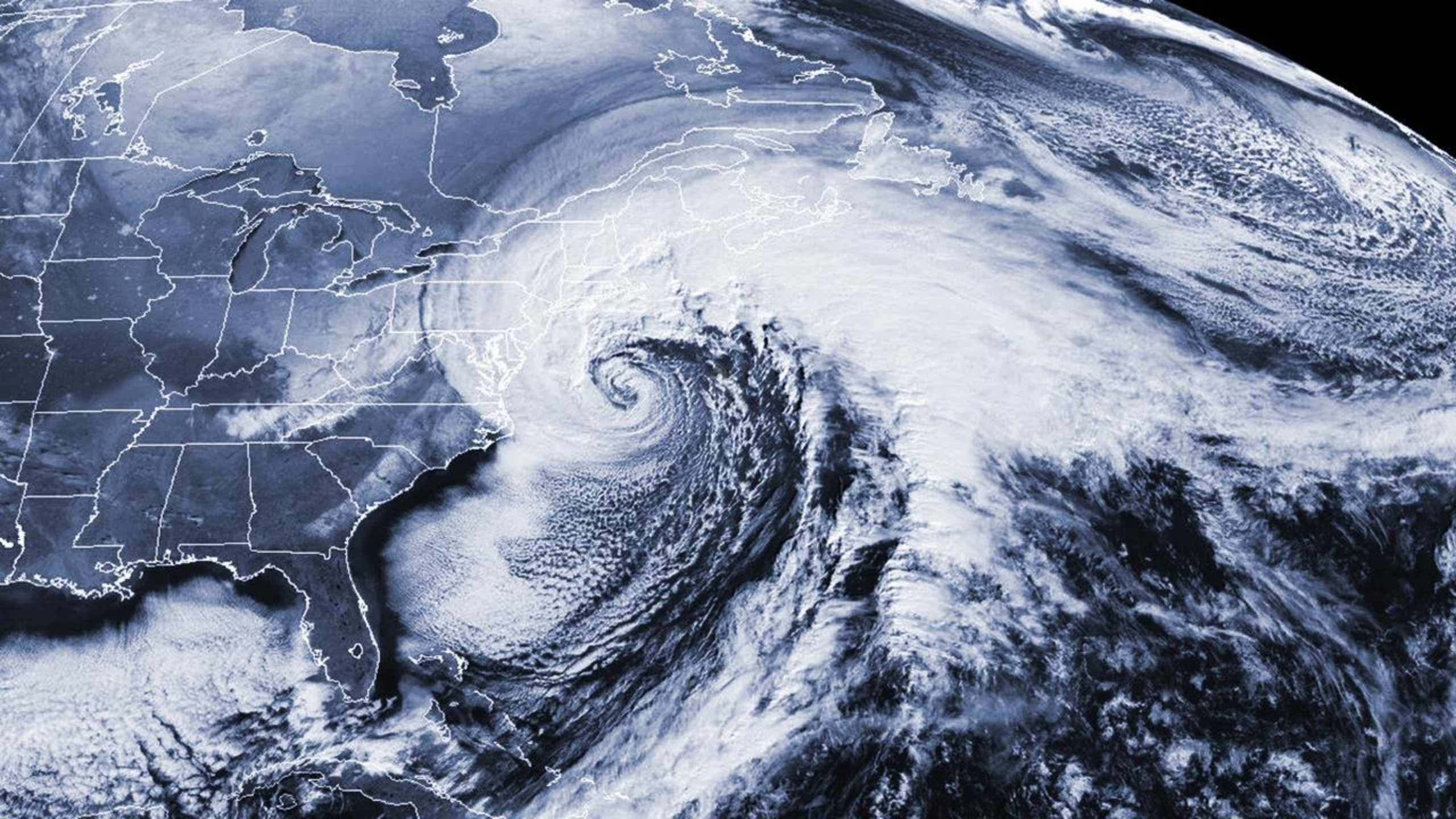




TEMPERATE CYCLONE

- **35° and 65° in both hemispheres**
- **Vertical thickness - 9 to 11 km**
- **Diameter - 1000 km**
- **Polar front theory**
- **Bomb cyclone**

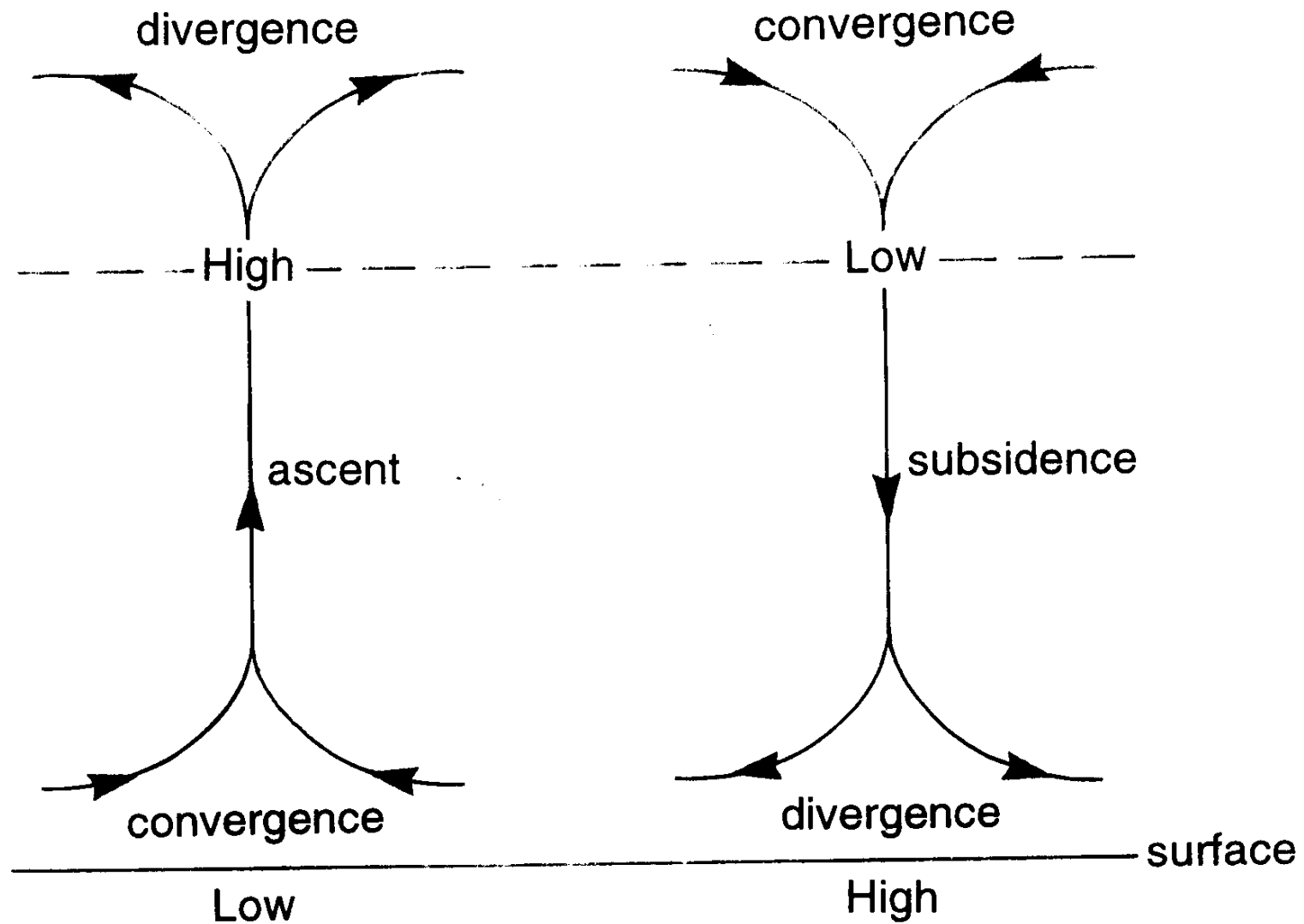




CLIMATOLOGY

TROPICAL CYCLONE

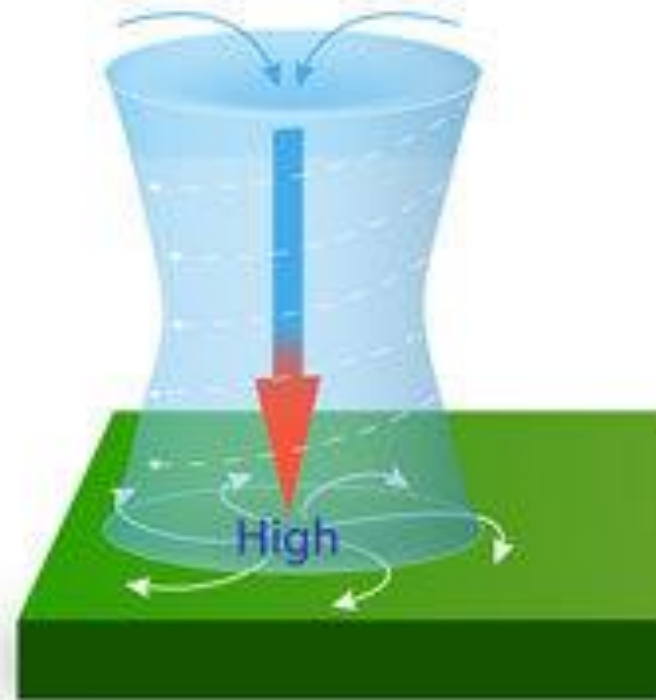
TROPICAL CYCLONES



CYCLONES

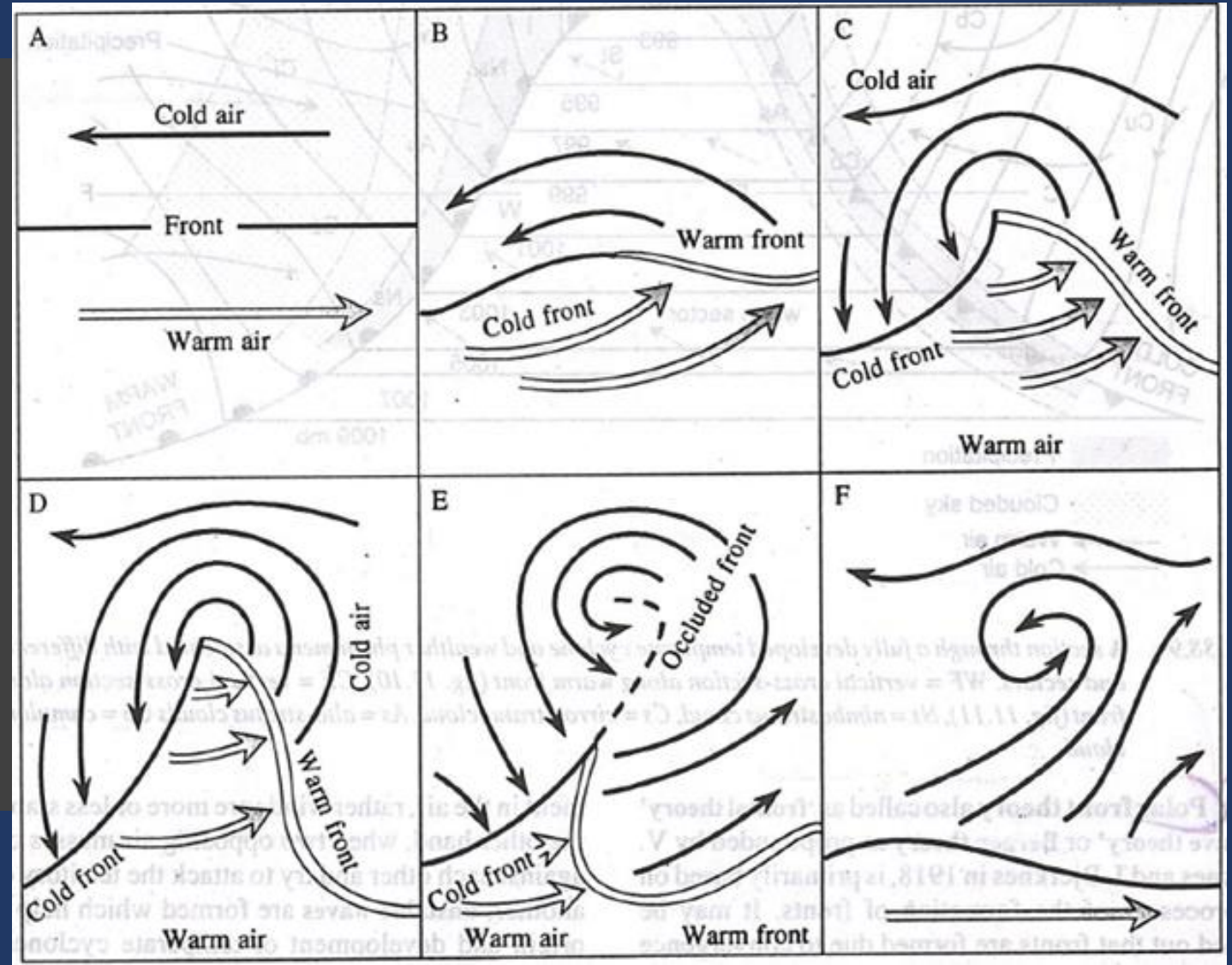


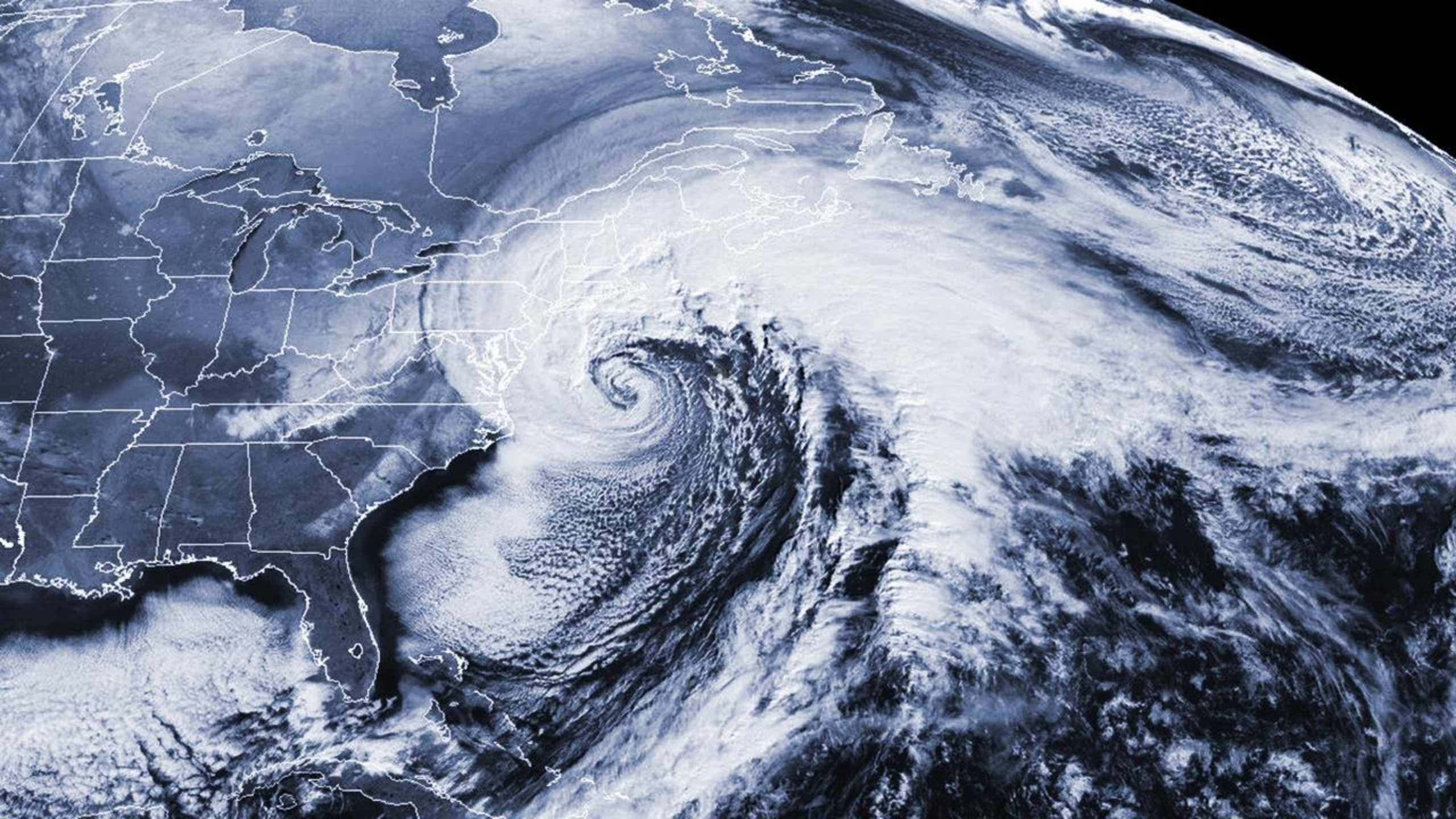
ANTICYCLONES



TEMPERATE CYCLONE/EXTRA TROPICAL CYCLONES

- **35° and 65° in both hemispheres**
- **Vertical thickness - 9 to 11 km**
- **Diameter - 1000 km**
- **Polar front theory**
- **Bomb cyclone**





FACTORS INFLUENCING TROPICAL CYCLONE FORMATION

- **Atmospheric moisture**
- **Warm ocean waters (Sea Surface Temperature)**
- **Coriolis force (8 to 20 degree N and S latitudes)**
- **Inter-Tropical Convergence Zone (ITCZ)**
- **Low values of vertical wind shear**
- **Pre-existing disturbance**

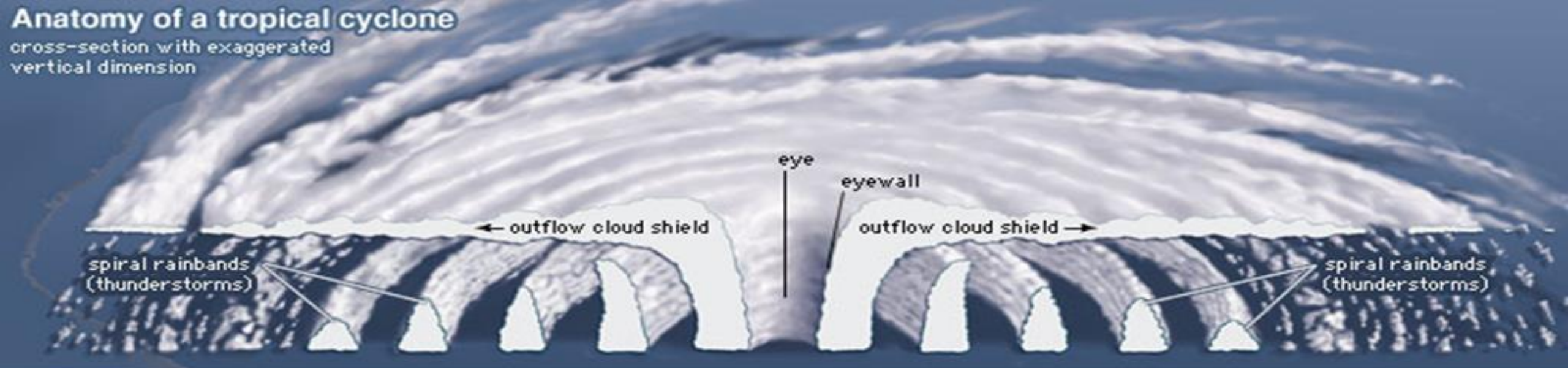
EYE & EYE WALL

- INTENSIFIED LOW PRESSURE REGION
- THE SKY WILL BE CLEAR
- WIND SPEED IS LEAST
- SUBSIDING WINDS AT THE CENTRE OF THE CYCLONE
- REGION WILL BE CALM

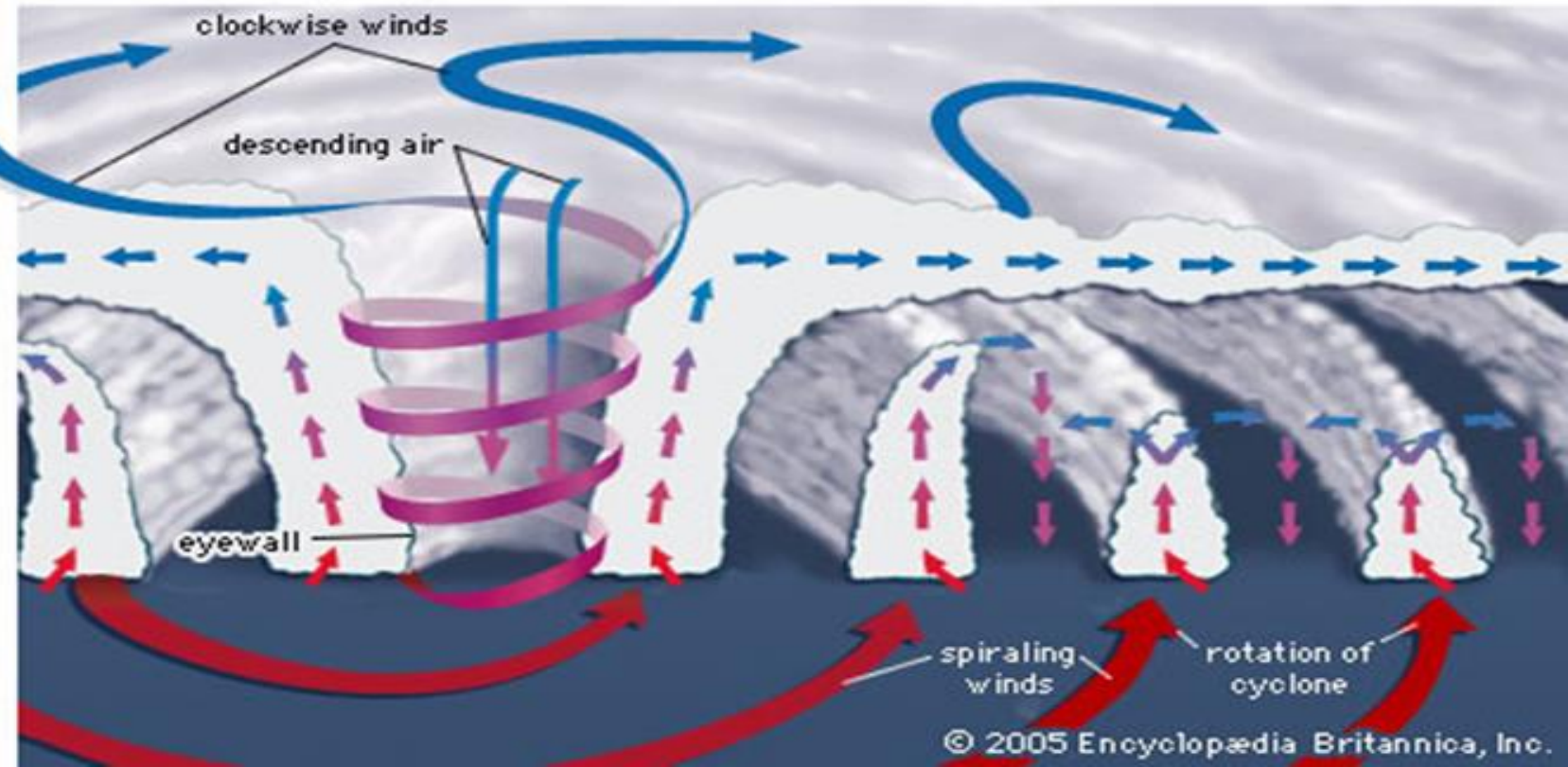
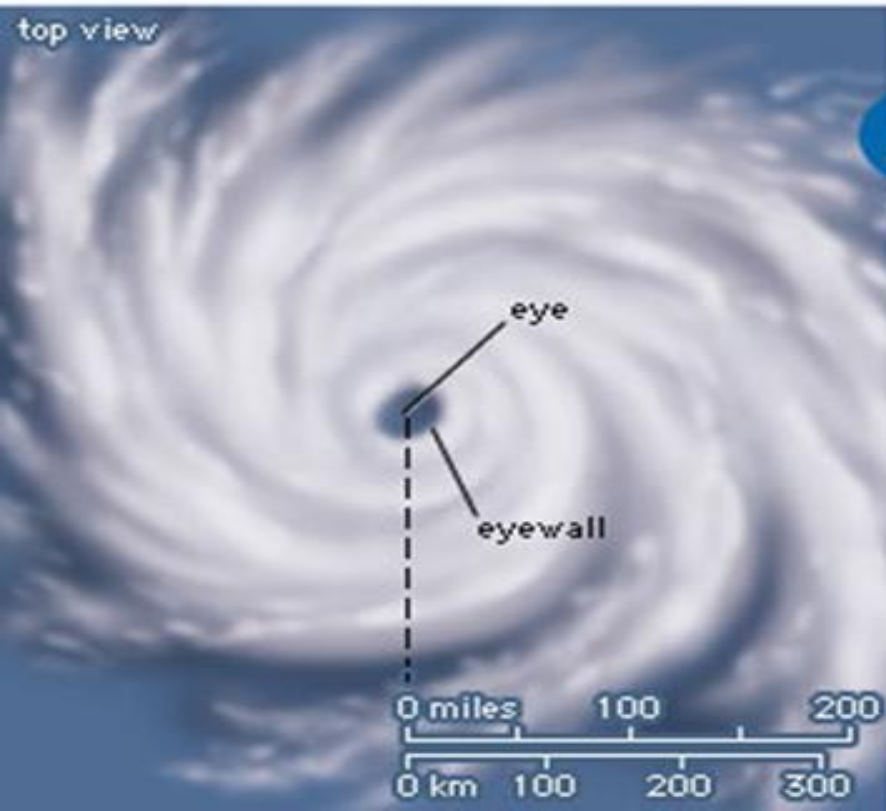
- MADE UP OF CUMULONIMBUS CLOUDS
- MAXIMUM RAINFALL
- MAXIMUM WIND SPEED
- MAXIMUM DESTRUCTION REGION

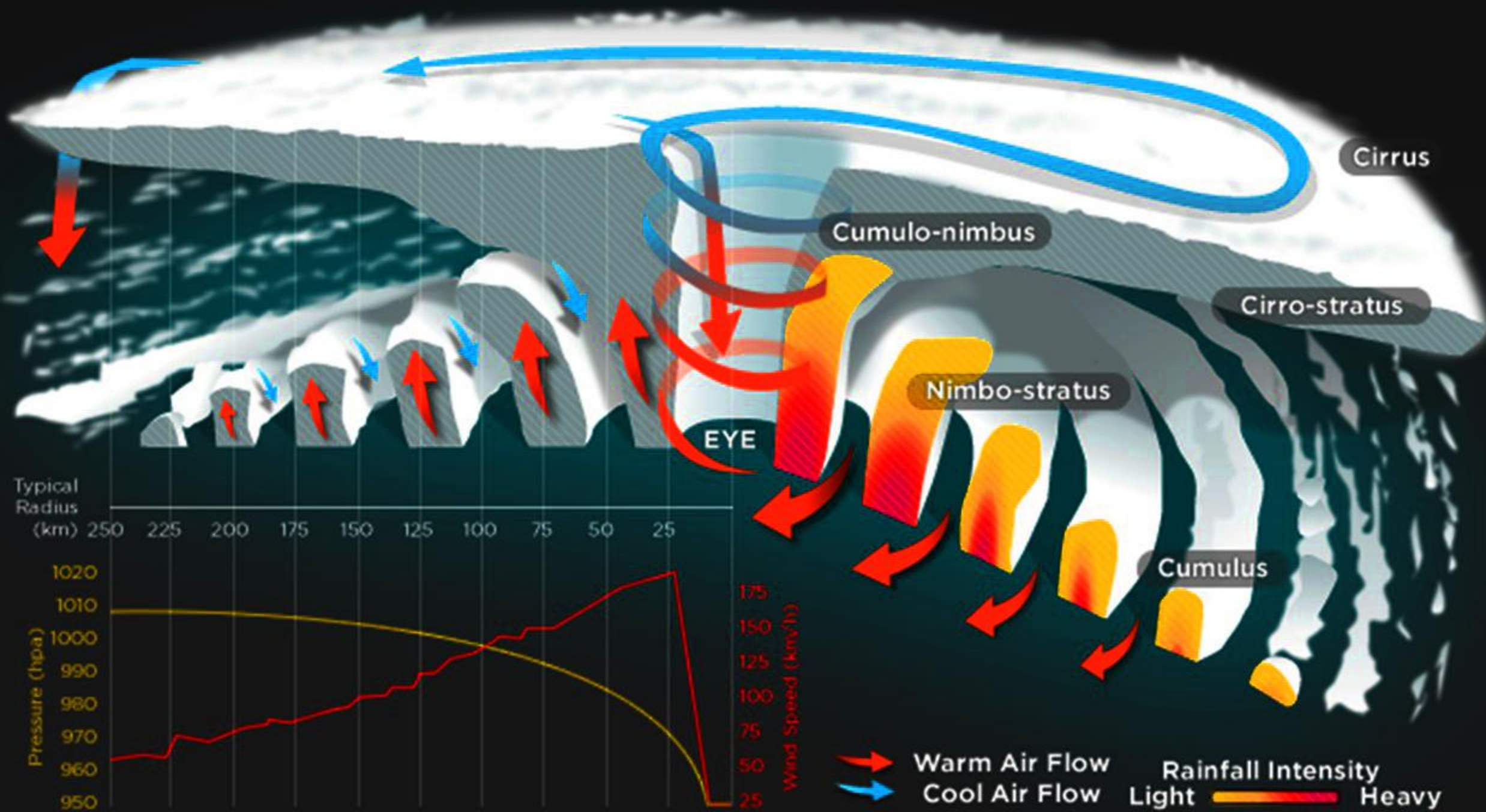
Anatomy of a tropical cyclone

cross-section with exaggerated vertical dimension

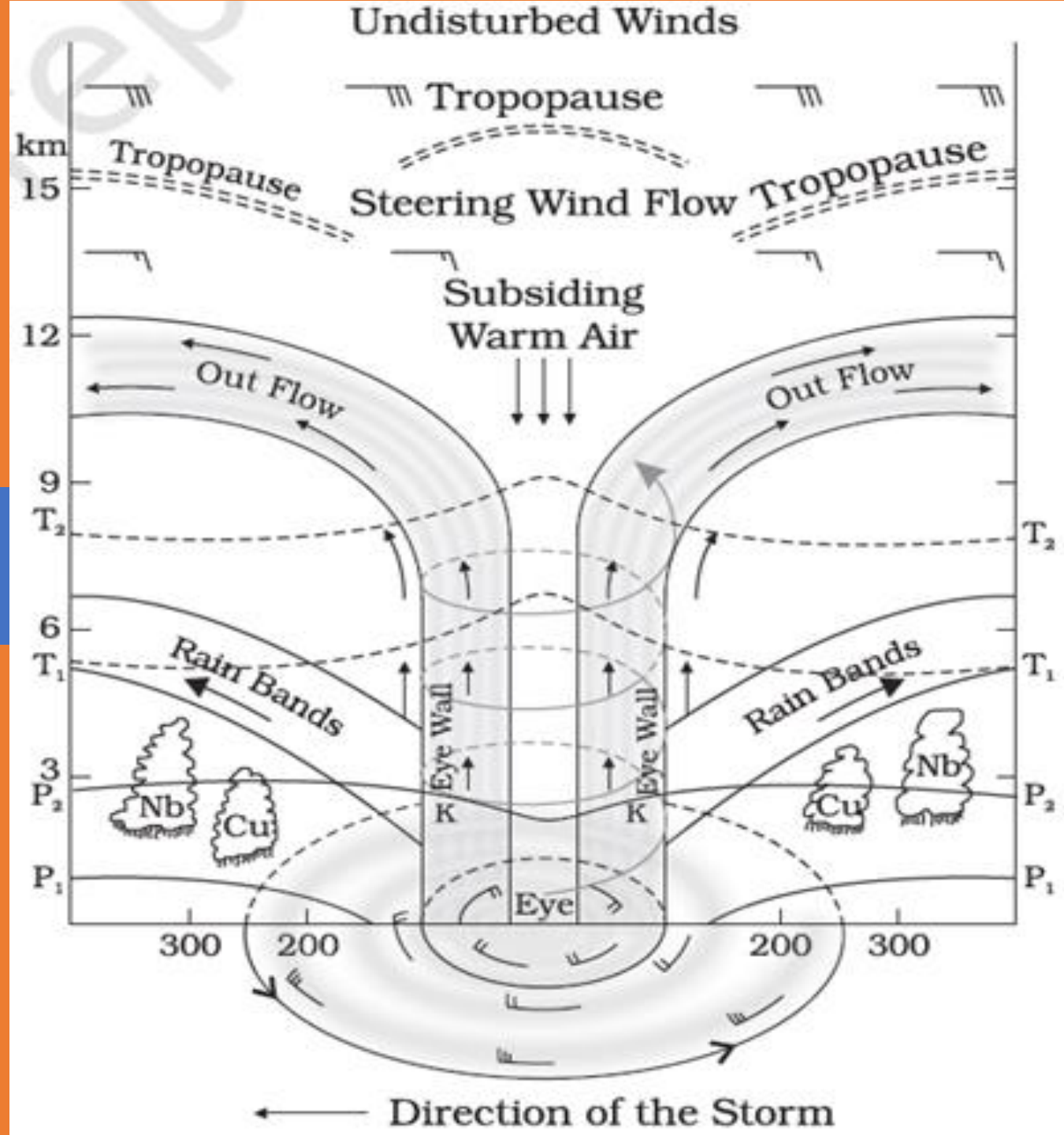


top view

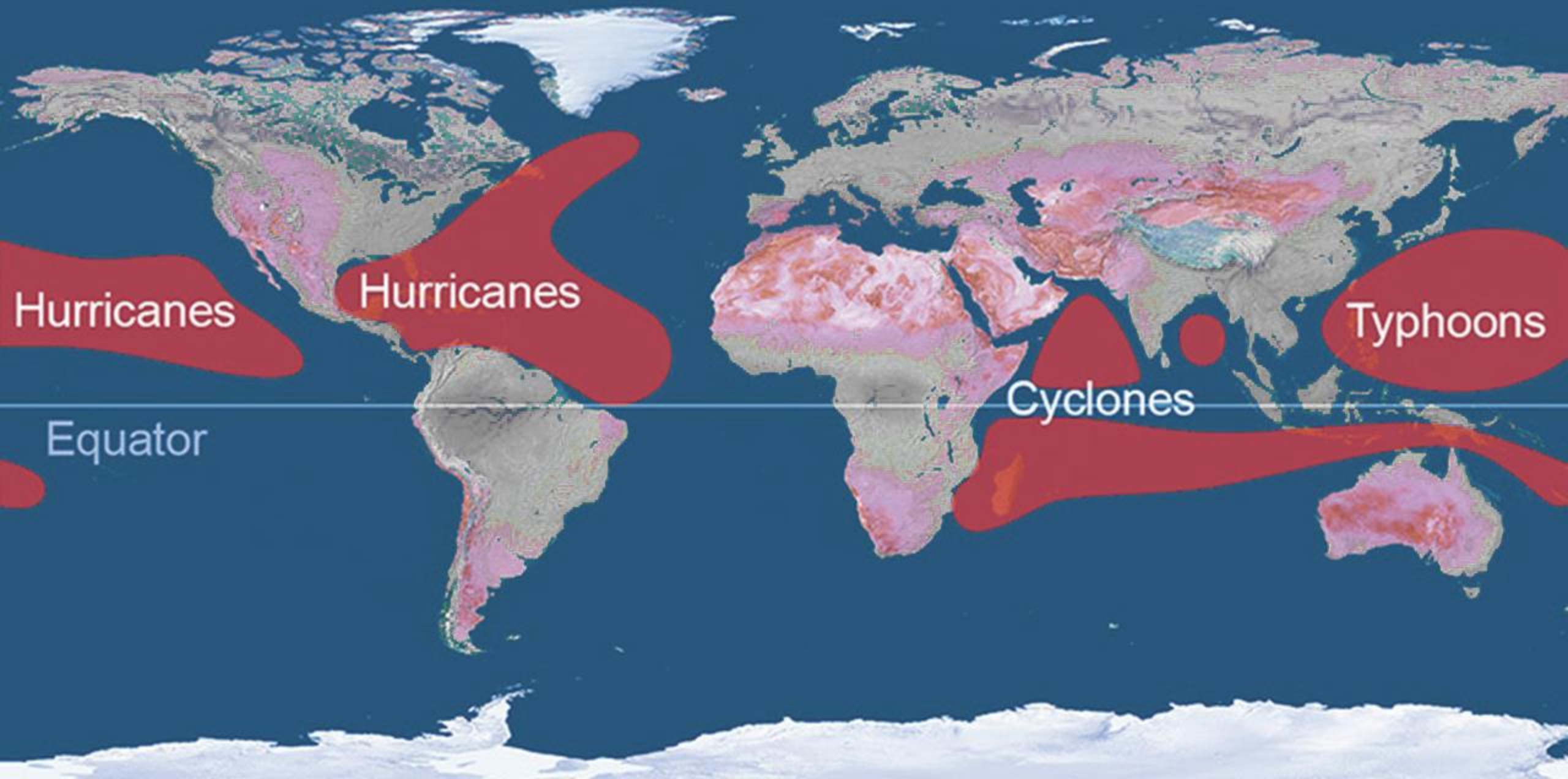




VERTICAL STRUCTURE



Tropical cyclone distribution



DIFFERENCE BETWEEN EXTRA-TROPICAL CYCLONES AND TROPICAL CYCLONES

- Frontal system
- Temperature contrast
- Land and sea
- Larger area
- West to east
- Low wind velocity
- Jetstream intensifies it

- Condensation
- Only over oceans
- East to west
- Higher wind velocity
- Jetstream weakens it

CLIMATOLOGY

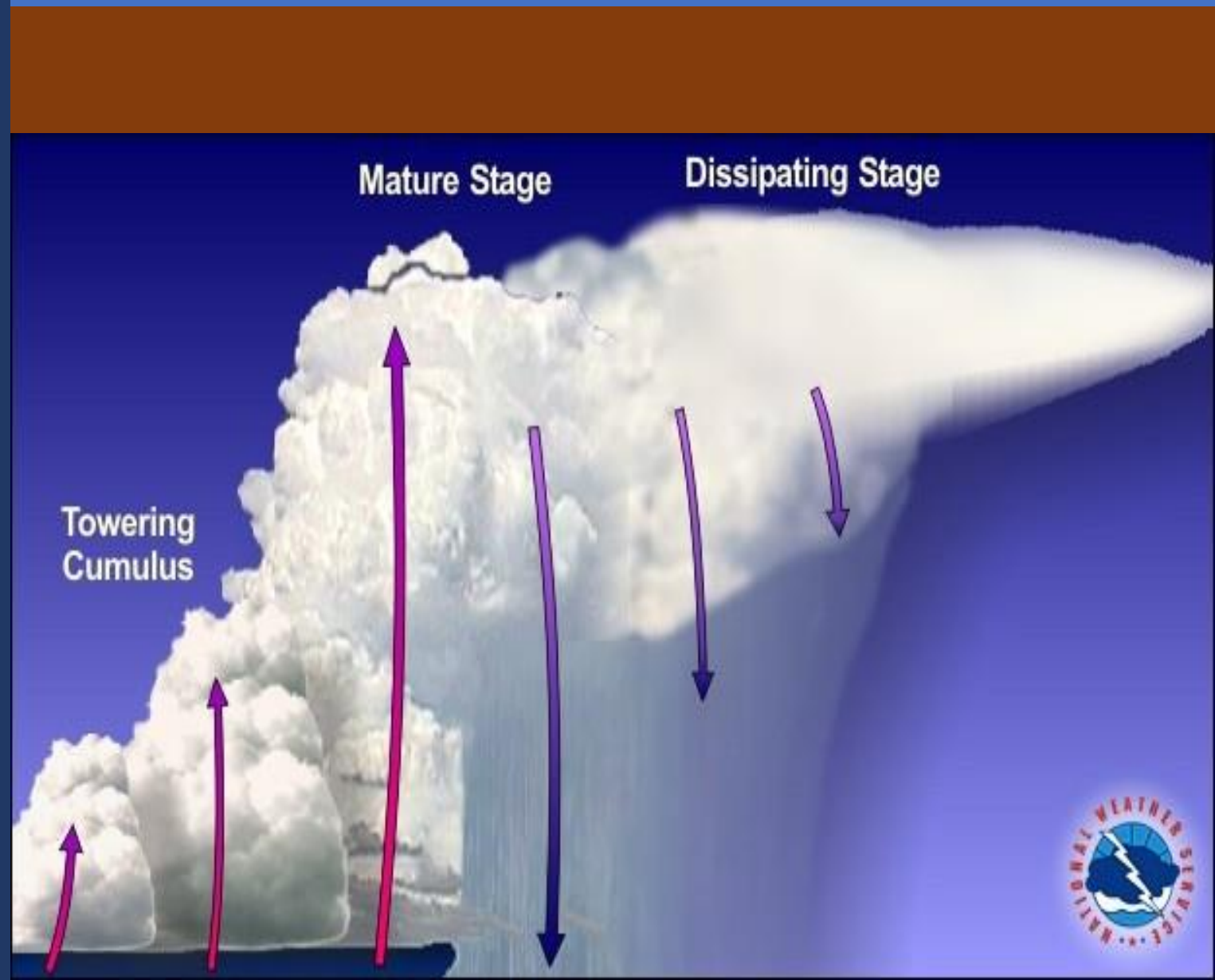
THUNDERSTORM, JETSTREAM, ANTI-CYCLONE & WESTERN DISTURBANCE

THUNDERSTORMS

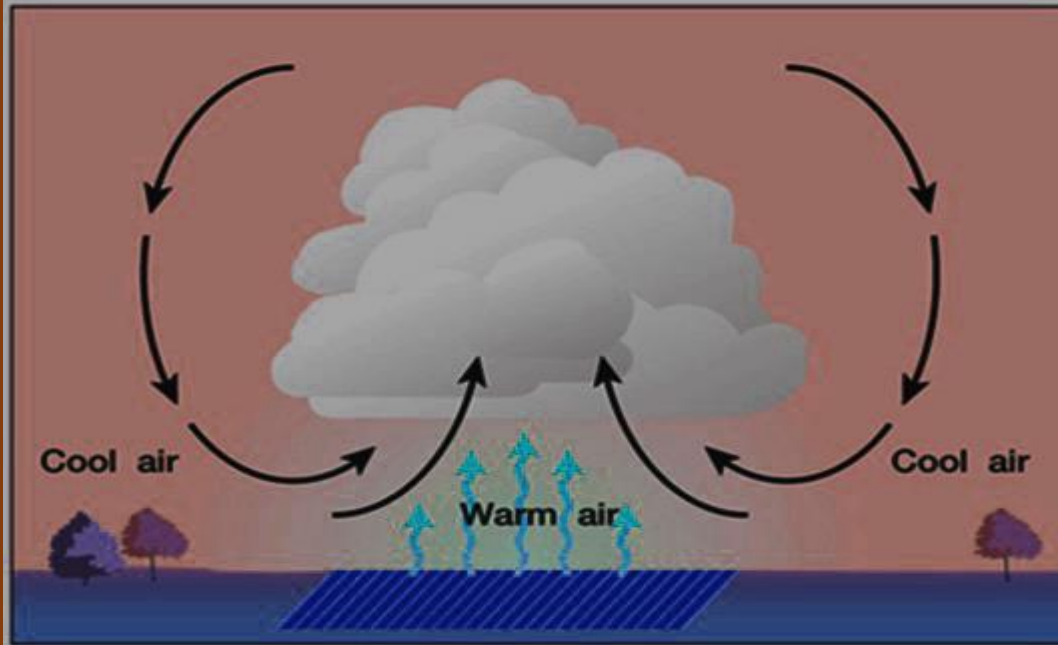
- **Cumulonimbus cloud producing thunder and lightning**
- **Warm moist air**
- **Uplifting mechanism**
- **Hailstorm**

➤ **THUNDERSTORMS IN INDIA**

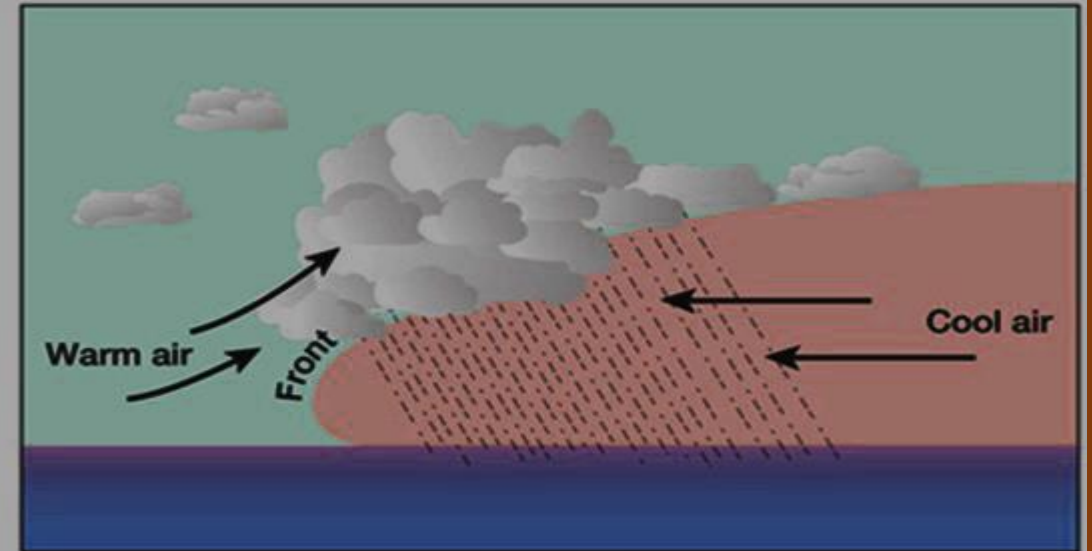
- **Western disturbances**
- **Nor Westers (Kalbaisakhi or Bordoisila)**



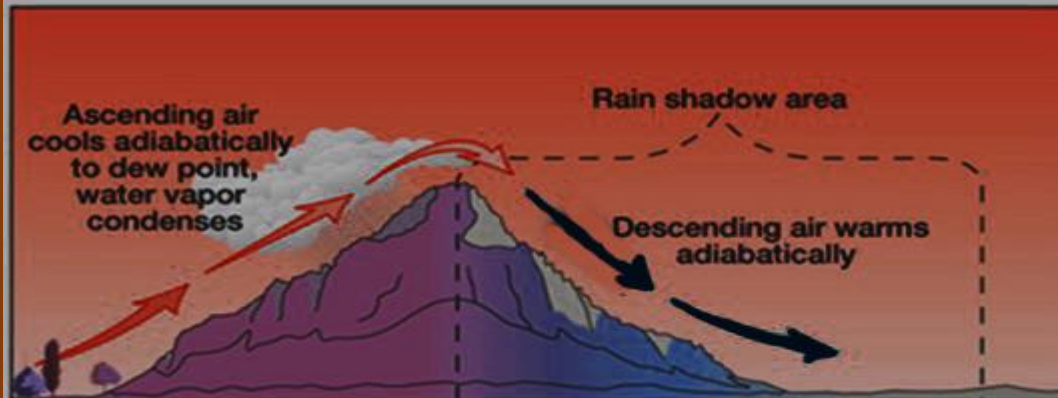
UPLIFTING MECHANISM



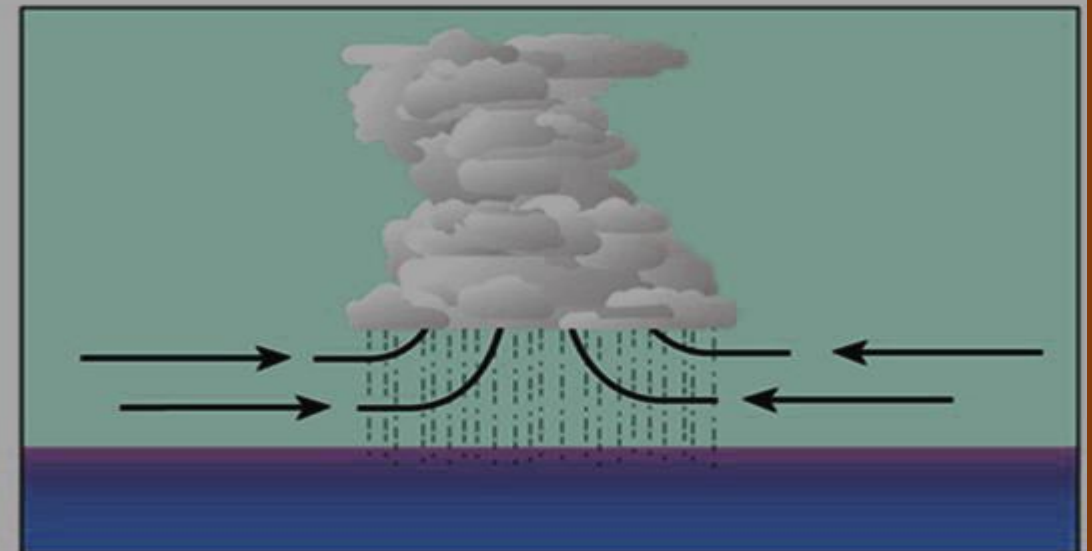
(a) Convective



(c) Frontal



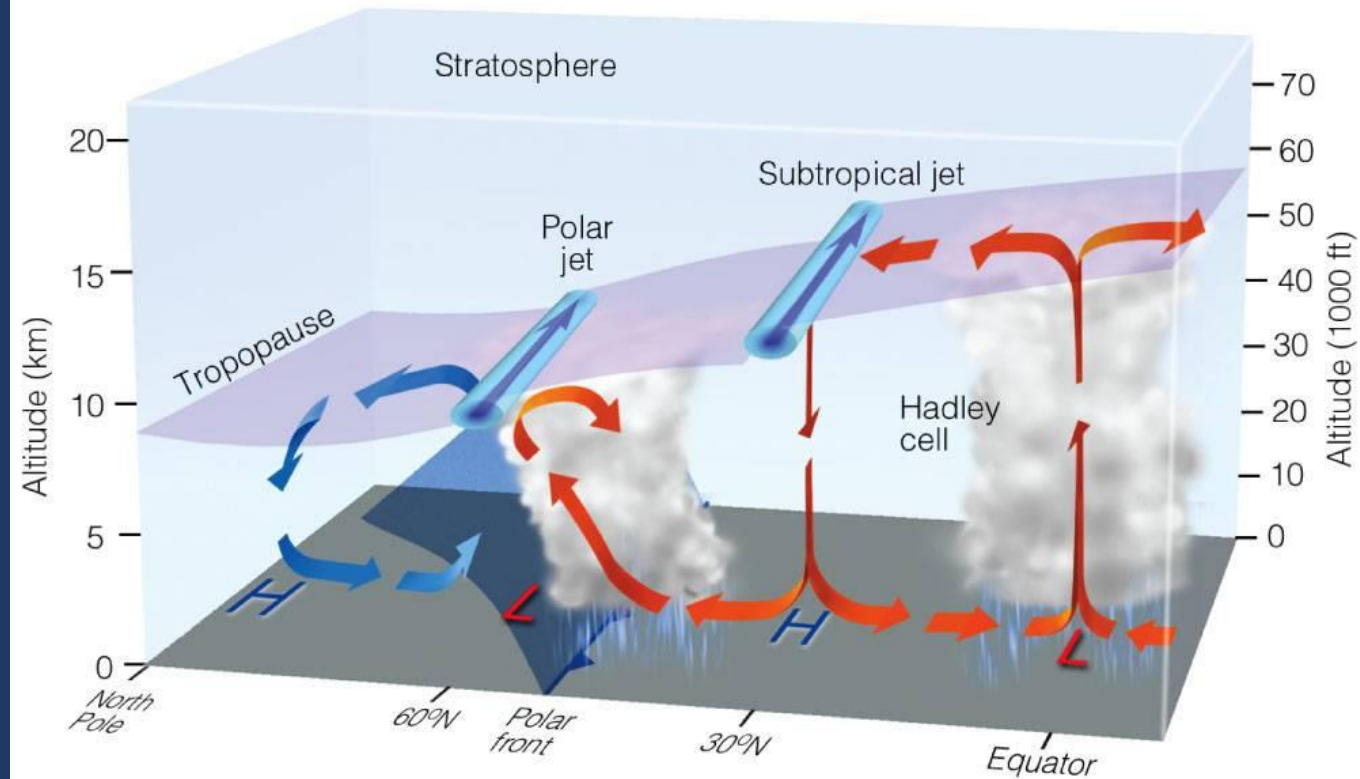
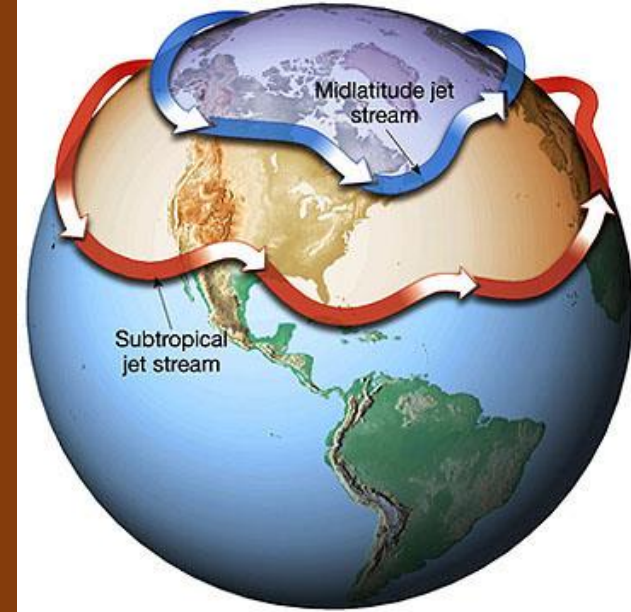
(b) Orographic



(d) Convergent

JETSTREAMS

- High-speed winds
- West to east
- Upper troposphere/tropopause
- Meandering bands of swift winds
- Very strong vertical wind shear



FEATURES

- Low pressure area
- Remnants of extra-tropical cyclones
- Originates in Caspian Sea or Mediterranean Sea
- Influenced by Westerlies and Sub-tropical Jetstream
- Moves west to east

EFFECTS

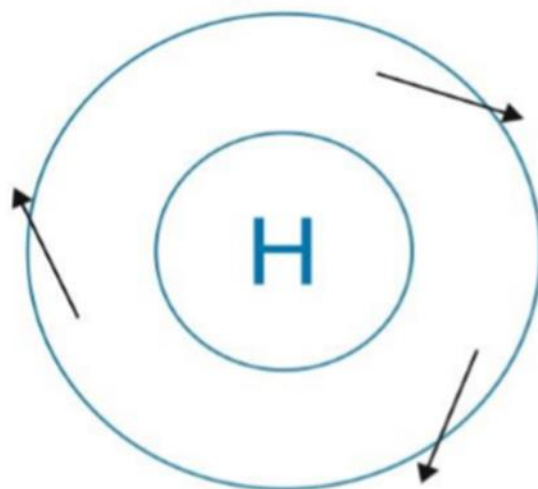
- Minimal Effect during the monsoon months in India
- Winter and pre-monsoon rainfall in Northwest India
- Snowfall in J & K
- Rabi crop
- Thunderstorms and dust storms

WESTERN DISTURBANCE

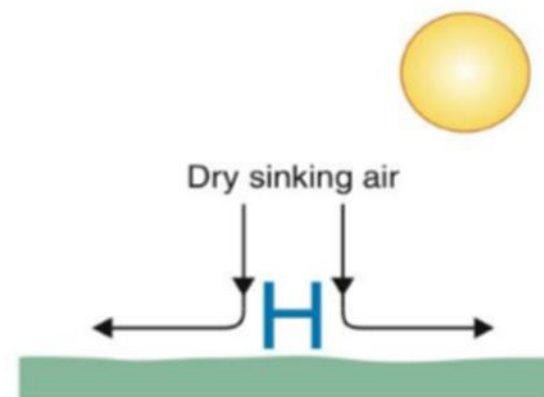


ANTI-CYCLONES

Surface winds blow clockwise around an anticyclone (high pressure) and diverge.



View from above



View from side

4. Consider the following statements:

(2001)

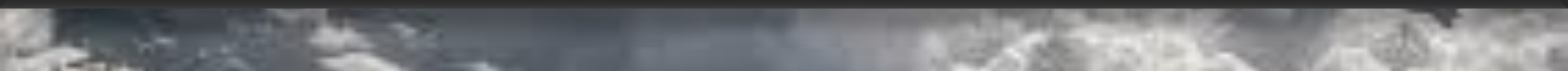
1. Anti-cyclonic conditions are formed in winter season when atmospheric pressure is high and air temperatures are low.
2. Winter rainfall in Northern India causes development of Anticyclonic conditions with low temperatures.

Which of the statement(s) given above is/are correct?

- (a) 1 only (b) 2 only (c) Both 1 and 2 (d) Neither 1 nor 2



CLIMATOLOGY



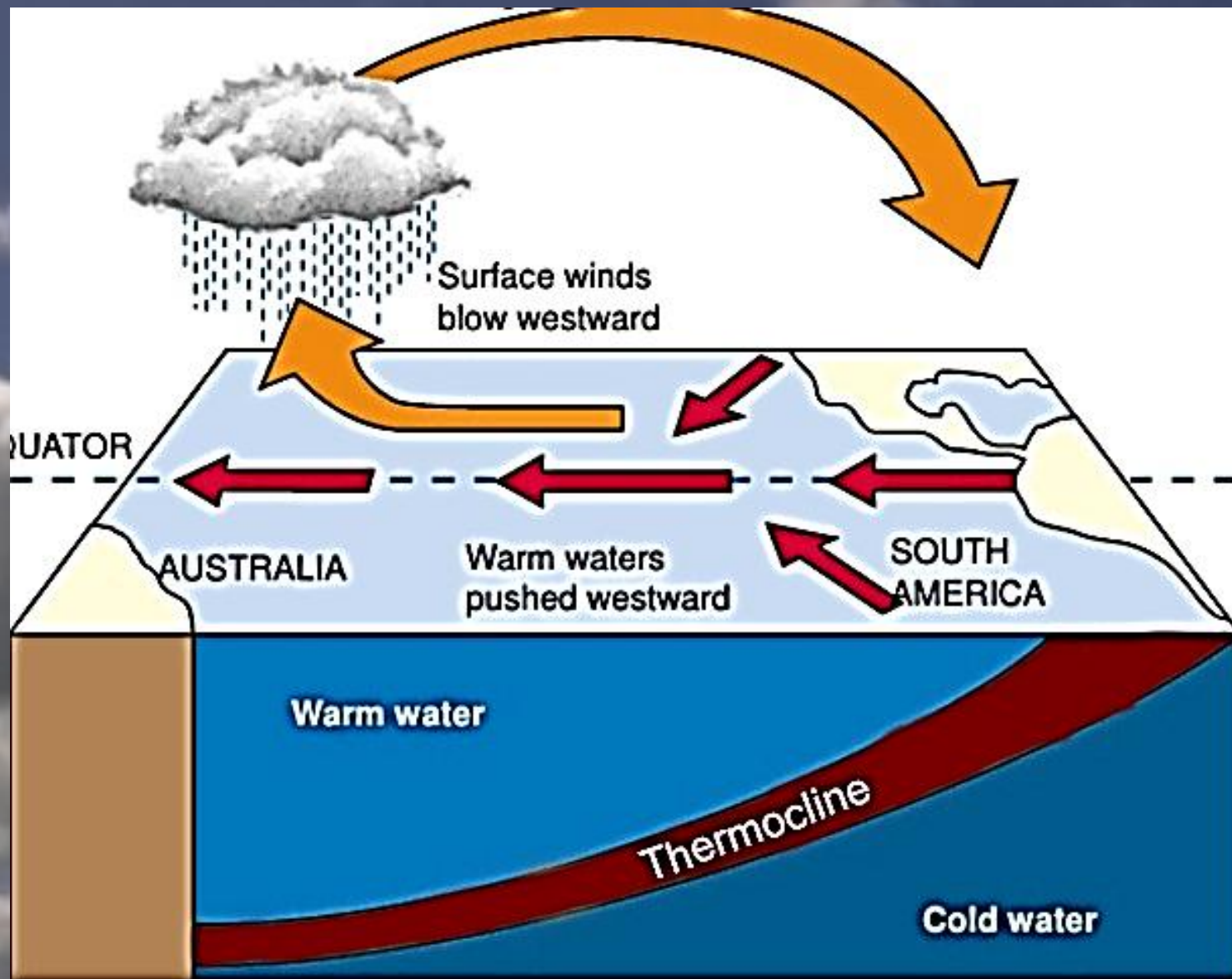
ENSO AND CLOUDBURST



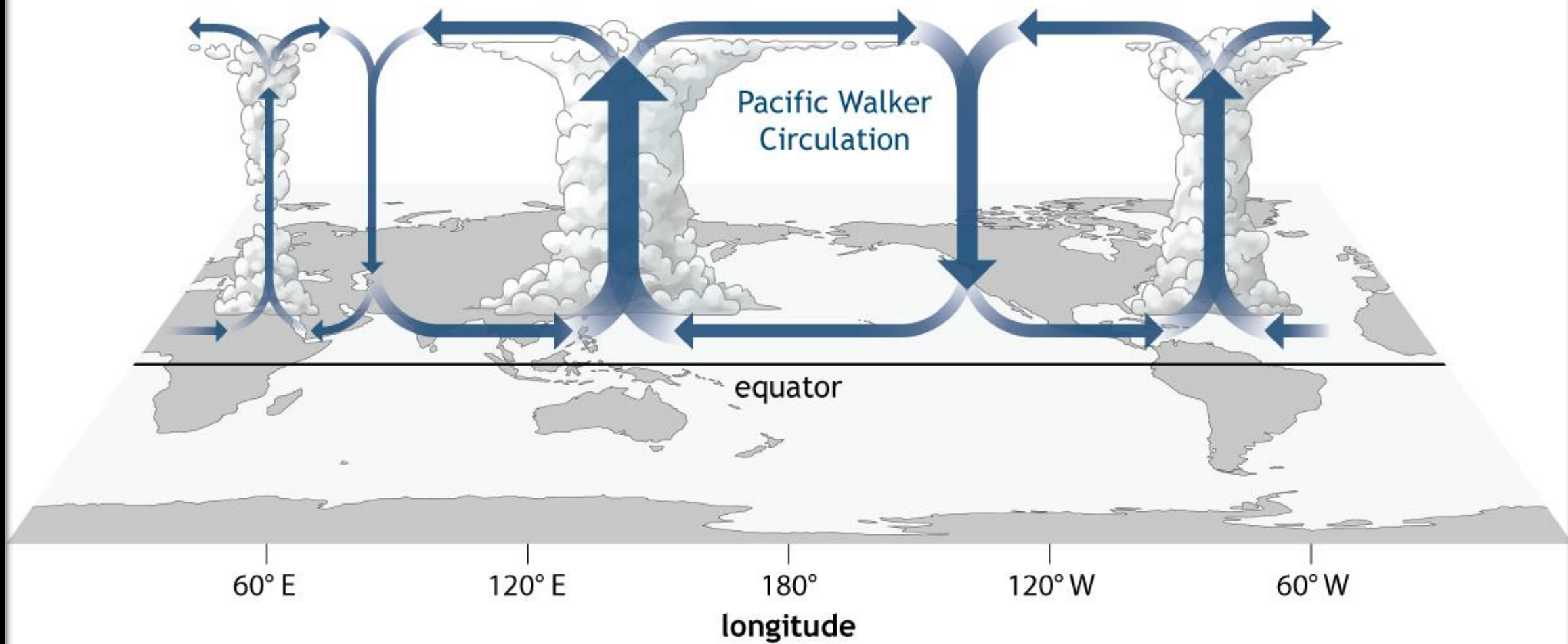


El Niño–Southern Oscillation

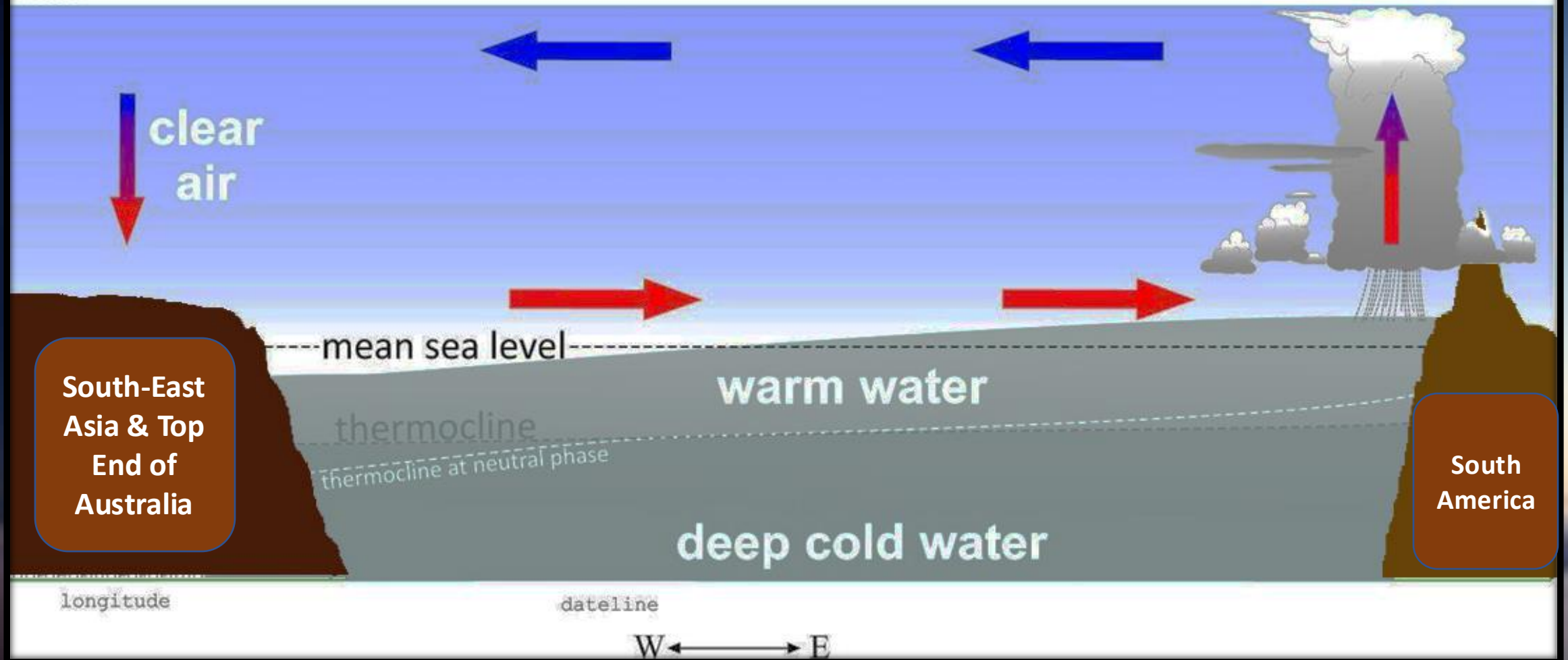
NEUTRAL YEAR



Neutral Condition

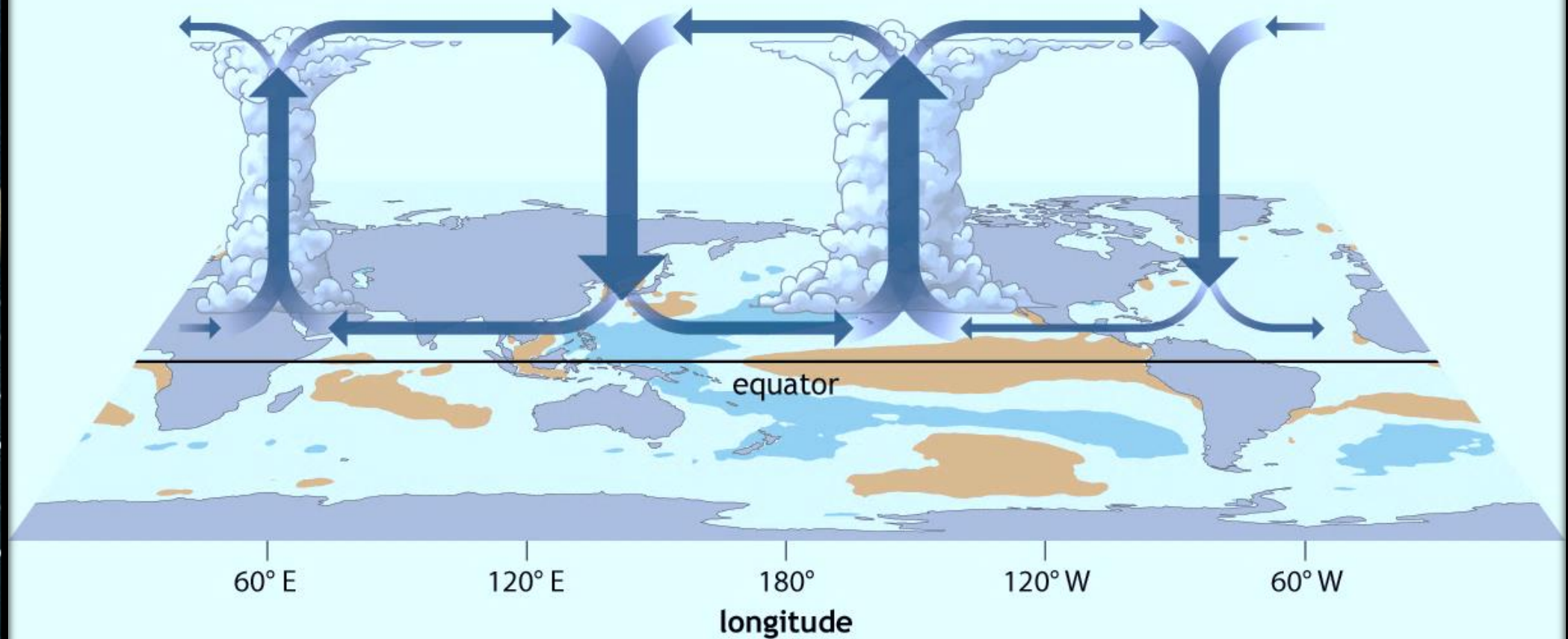


Niño

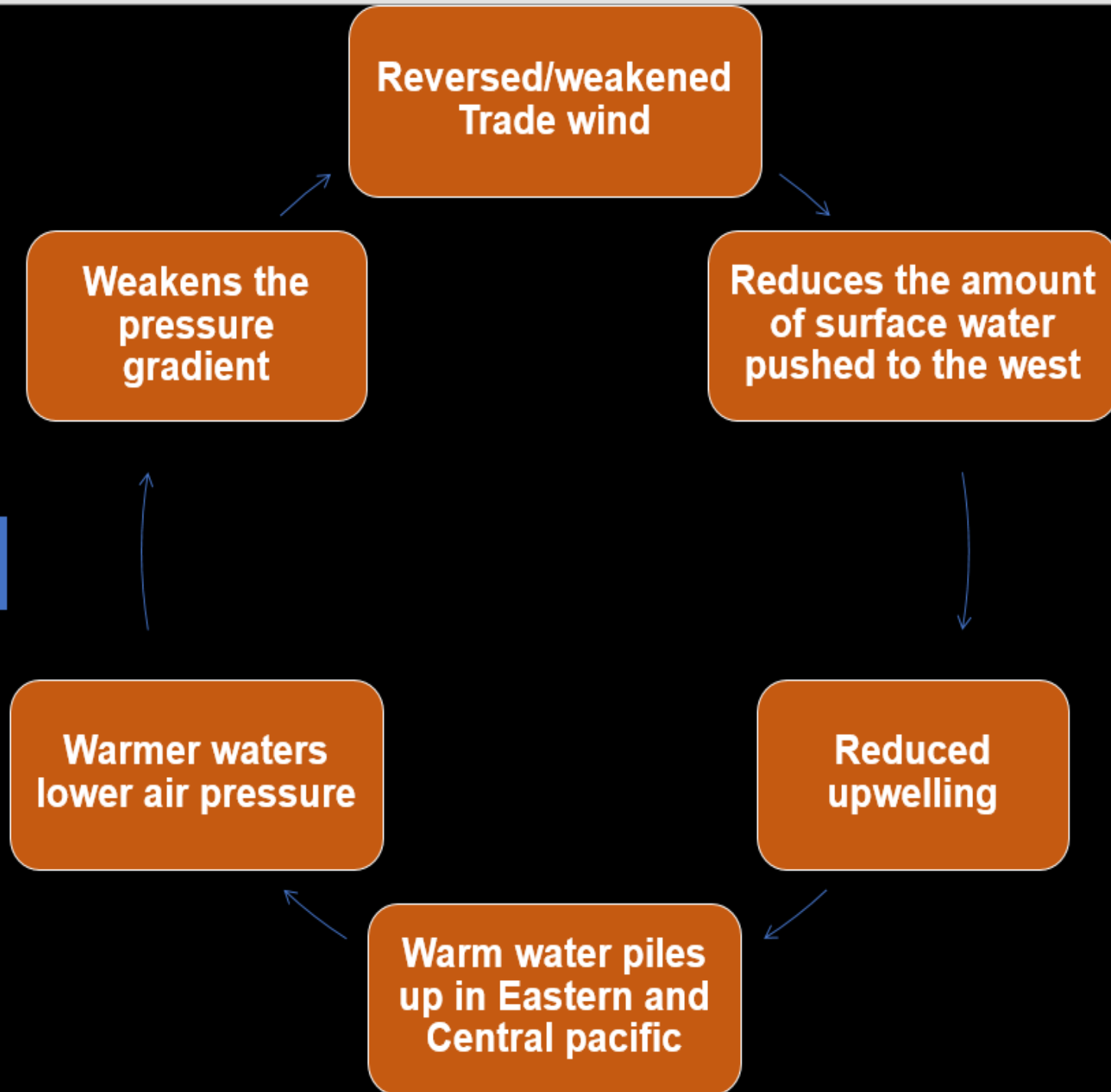


EL NINO

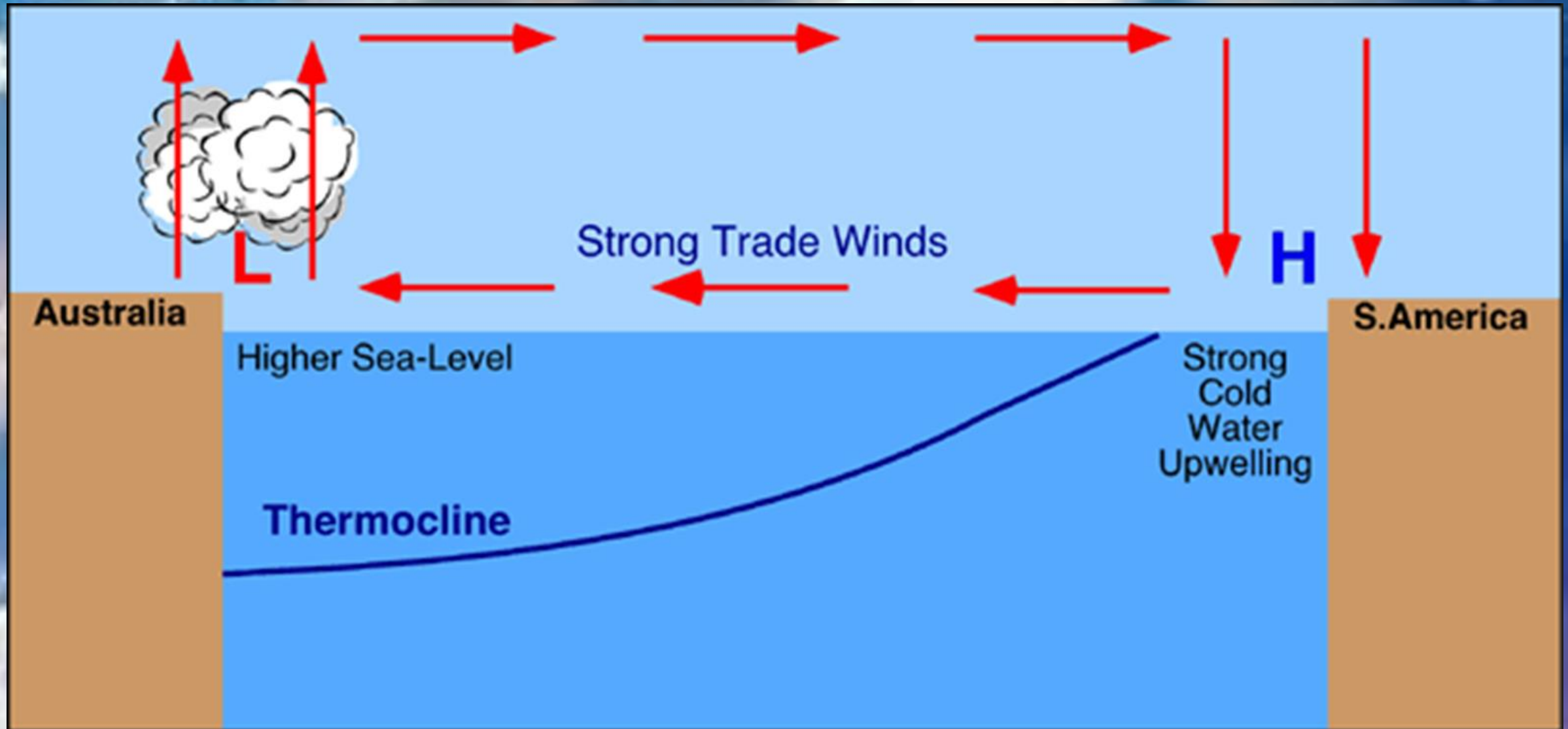
El Nino Condition



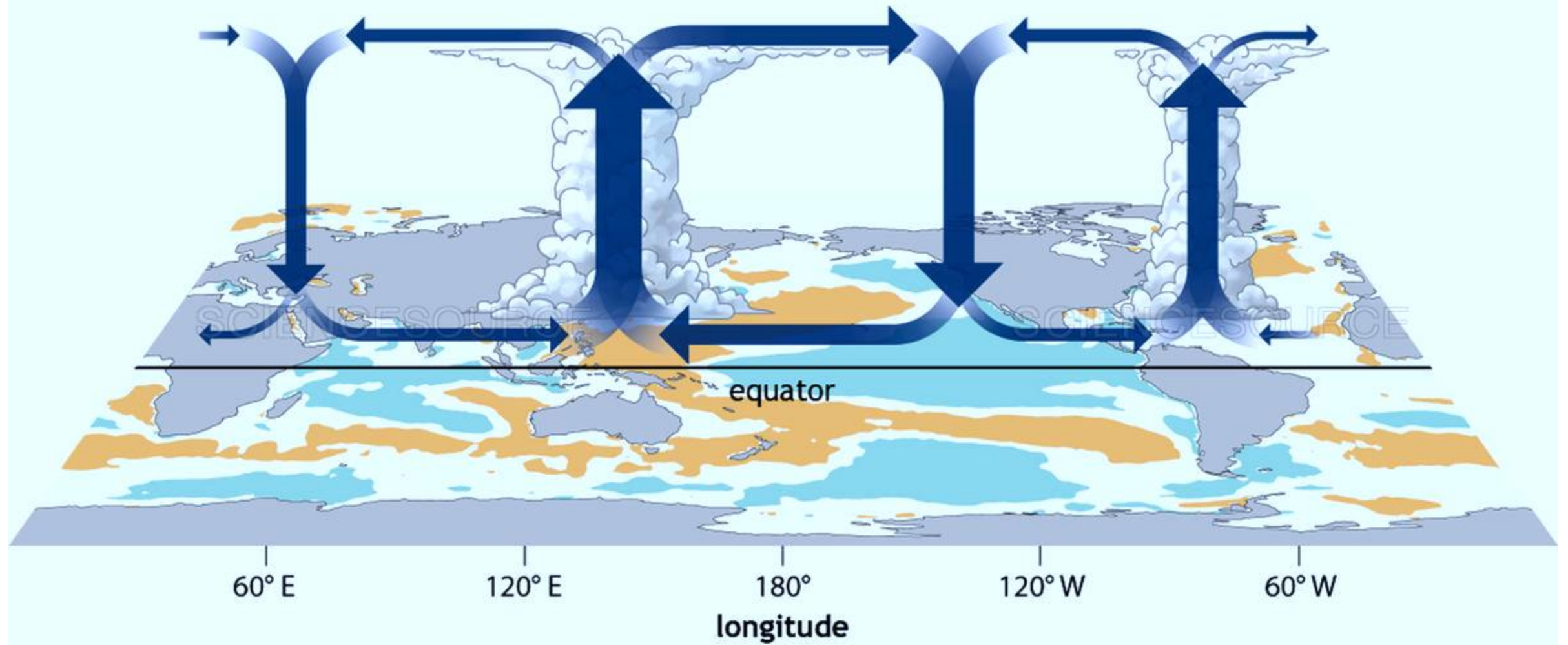
FORMATION



LA NINA



La Nina Condition



FEATURES	EL NINO	LA NINA
Trade winds	Reversed or weakened	Unusually hard trade winds
Sea Surface Temperature	Central and eastern pacific -> Warmer Western Pacific -> Colder	Western Pacific -> Warmer than normal Central and eastern pacific -> Very cold
Air pressure	Eastern pacific -> Low pressure Western pacific -> High pressure	Western pacific -> Low pressure Eastern pacific -> Very high pressure
Upwelling	Reduced upwelling	Increased upwelling
Rainfall	Eastern Pacific – high Western Pacific – low	Eastern Pacific – low Western Pacific – high
Effect on India	Below normal monsoon and droughts	Above normal rainfall and floods

The image features a vast, deep blue sky as the background. In the lower half, a large, dense, and billowing white cloud formation rises, resembling a massive plume of smoke or a large cumulus cloud. The cloud has a textured, puffy appearance with various shades of white and light blue. In the upper half, the sky is a clear, deep blue with some wispy, lighter blue clouds scattered across it. Centered horizontally and partially overlaid by the cloud formation is the word "CLOUDBURST" in a bold, white, sans-serif font. The text has a thick black outline and is enclosed within a thin red rectangular border.

CLOUDBURST

✓ **Sudden Heavy
Rainfall (100 mm
Per Hour)**

✓ **Short Duration**

✓ **Small Geographical
Area**

✓ **Hilly Areas**

✓ **Cloud's Burst?**

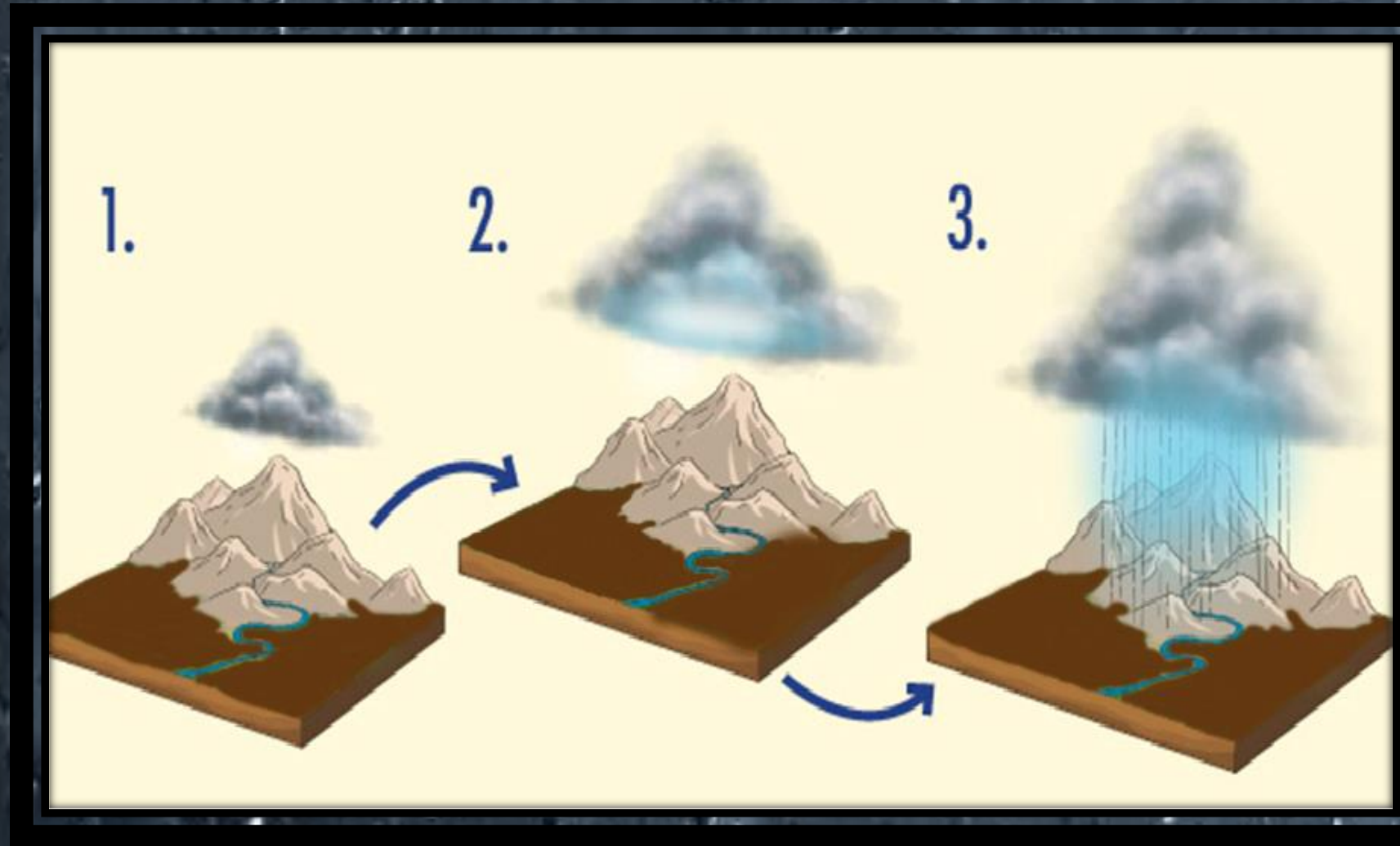


❑ FORMATION

- **Vertical winds**
- **Coalescing rain droplets**
- **Hilly terrain**
- **Monsoon clouds**
- **Vertical and high clouds**

❑ EFFECTS

- **Flash floods**
- **Landslide and Mudslide**
- **Thunderstorms and hail formation**



MODEL QUESTION (PRELIMS)

With reference to 'Cloudbursts', consider the following statements:

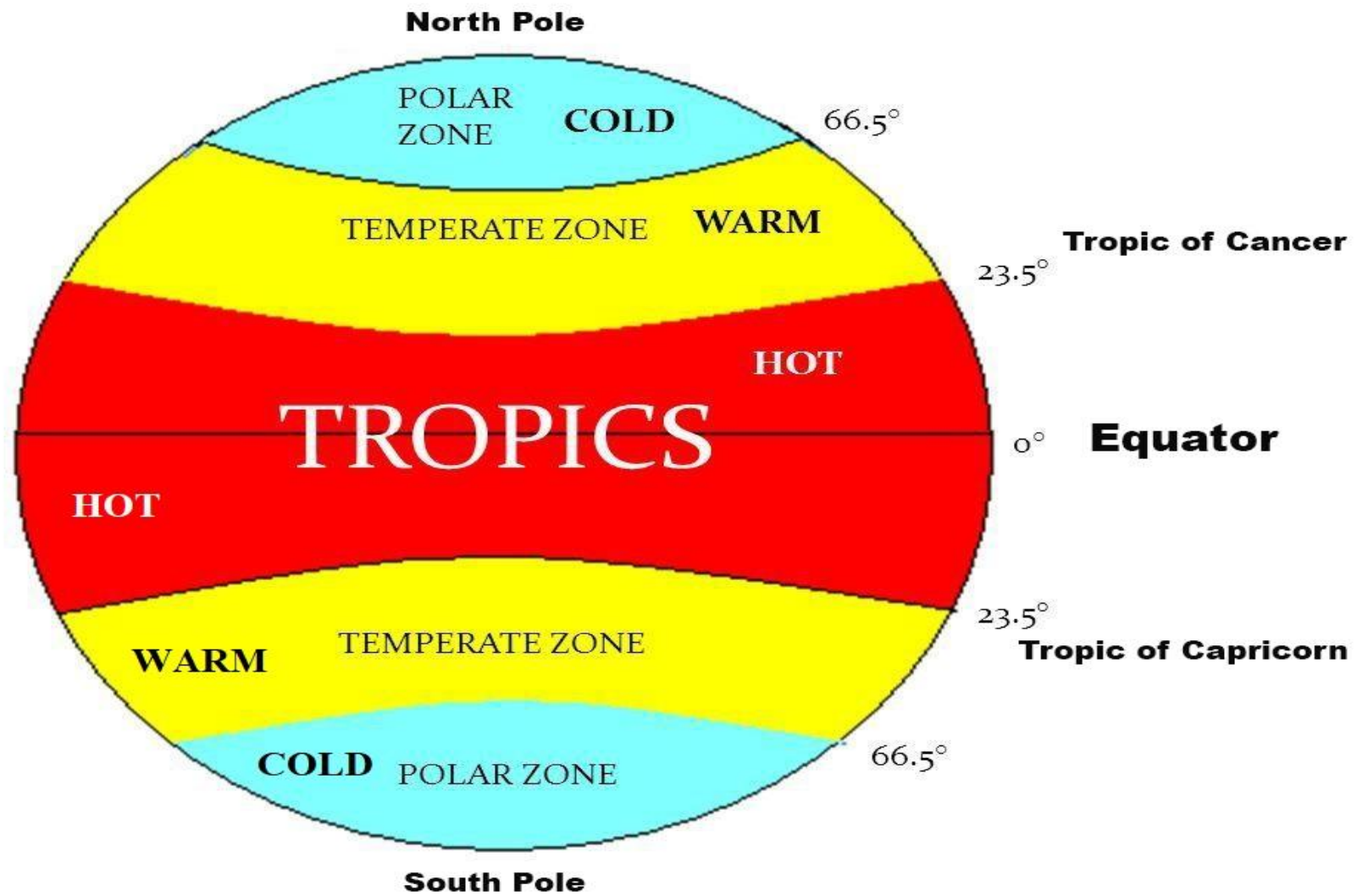
1. It refers to sudden and copious rainfall over a small area.
2. They are generally associated with thunderstorms.
3. It refers to breaking open of a cloud resulting in release of huge amounts of water.
4. They are formed by orographic lift.

Which of the statements given above are correct?

- (a) 1, 2 and 3 only (b) 2 and 4 only (c) 1 and 3 only (d) 1, 2 and 4 only

The background of the image is a landscape under a dramatic sky. The sky is filled with clouds in shades of orange, yellow, and grey, suggesting a sunset or sunrise. The ground in the foreground is dry, cracked, and brown, indicating a hot, arid climate. A dark red rectangular box is centered horizontally across the middle of the image, containing the title text in white.

IMPORTANT CLIMATIC TYPES OF THE WORLD



THE EQUATORIAL CLIMATE

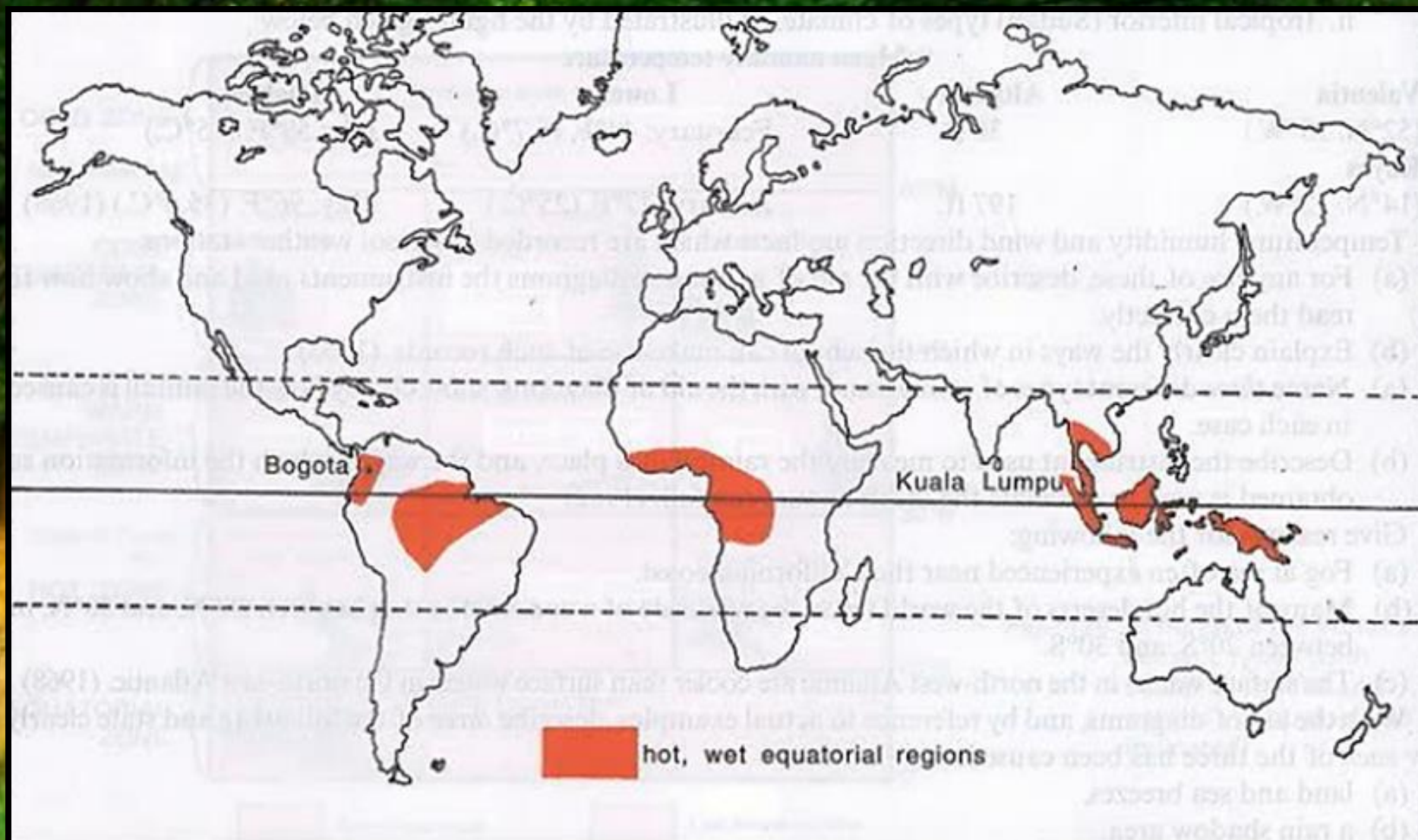
- UNIFORMITY OF TEMPERATURE
- CLOUDINESS AND HEAVY PRECIPITATION (60 – 100 Inches)
- WELL DISTRIBUTED RAINFALL (CONVECTIONAL)
- NO WINTER AND DRY SEASON
- DOUBLE RAINFALL PEAKS
- MORNING ARE BRIGHT AND SUNNY
- CUMULONIMBUS CLOUDS AT AFTERNOON

VEGETATION

- TROPICAL RAIN FORESTS (SELVAS)



- FOUND IN THE LOWLANDS OF THE AMAZON, THE CONGO, MALAYSIA AND THE EAST INDIES
- LUXURIANT TYPE OF VEGETATION
- EVERGREEN TREES THAT YIELD TROPICAL HARDWOOD
- MAHOGANY, EBONY, GREENHEART, CABINET WOOD.
- LIANAS, EPIPHYTIC AND PARASITIC PLANTS ARE ALSO FOUND
- SHIFTING CULTIVATION. MANIOC(TAPIOCA), YAMS, MAIZE, BANANAS AND GROUNDNUTS
- WILD RUBBER IN AMAZON BASINS, NUTS, CANE IN MALAYSIA
- mangrove forests: In the coastal areas and brackish swamps



TROPICAL MONSOON CLIMATE

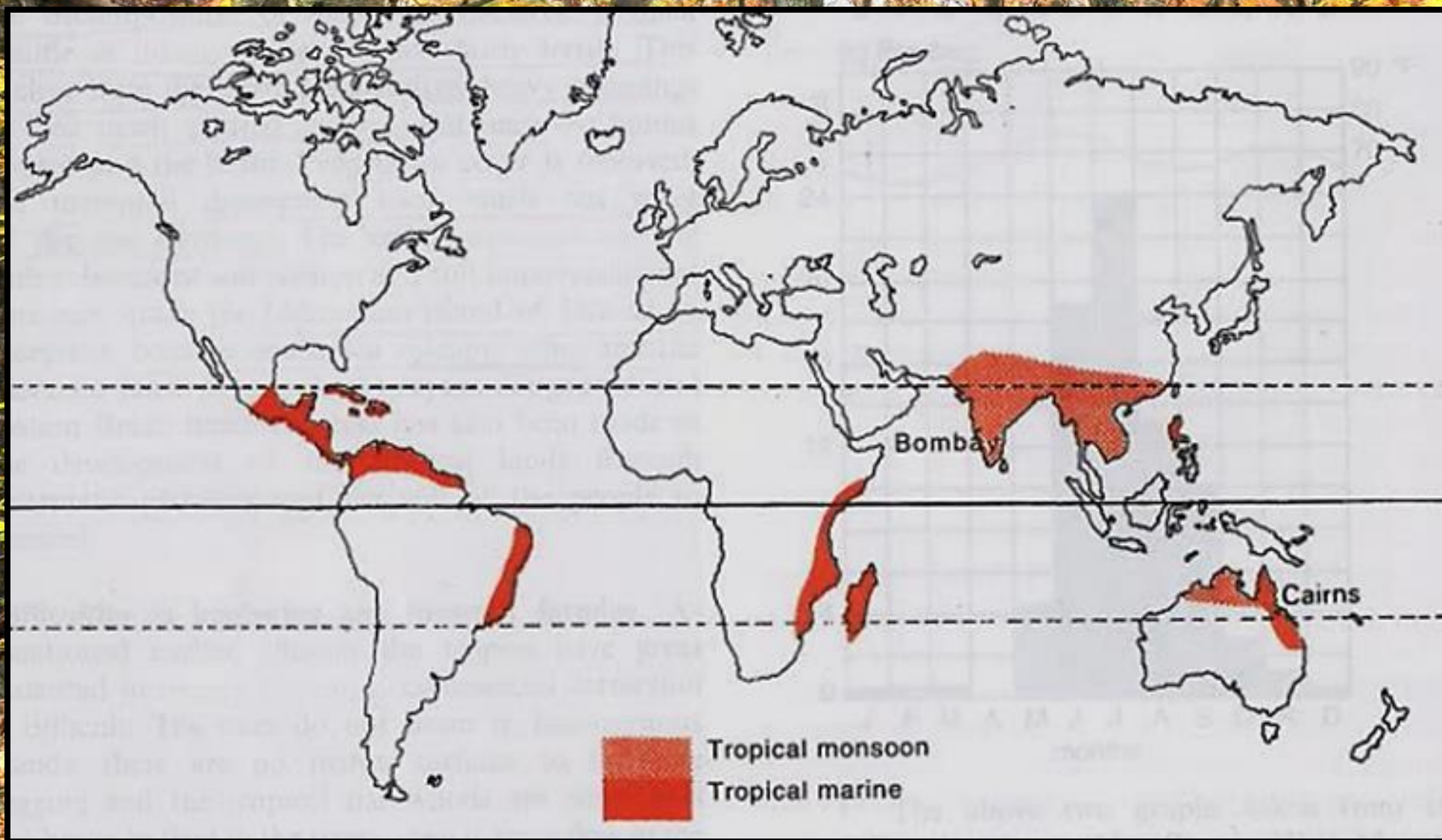
- ON SHORE WET MONSOON (SUMMER)
- OFF SHORE DRY MONSOON (WINTER)
- COOL DRY SEASON (OCTOBER TO FEBRUARY)
- HOT DRY SEASON (MARCH TO MID-JUNE)
- RAINY SEASON (MID-JUNE TO SEPTEMBER)
- CONCENTRATED HEAVY RAINFALL IN SUMMER

VEGETATION

- MONSOON FORESTS (DECIDUOUS)



- **FOUND IN INDIAN SUB-CONTINENT, BURMA, THAILAND, LAOS, CAMBODIA, PARTS OF VIETNAM, SOUTH CHINA AND NORTHERN AUSTRALIA**
- **TROPICAL MARINE CLIMATE IN CENTRAL AMERICA, WEST INDIES, NORTH – EASTERN AUSTRALIA, THE PHILLIPPINES, PARTS OF EAST AFRICA, MADAGASCAR, THE GUINEA COAST AND EASTERN BRAZIL.**
- **MAINLY AGRICULTURE, CROPS LIKE RICE, CANE SUGAR, JUTE etc**



TROPICAL MARINE CLIMATE

- EASTERN COAST OF TROPICAL LANDS
- INFLUENCE OF ON - SHORE TRADE WINDS
- MAXIMUM RAINFALL DURING SUMMER
- NO DRY PERIOD
- CYCLONIC ACTIVITIES

SAVANNAH OR SUDAN CLIMATE

- **TRANSITIONAL TYPE OF CLIMATE**
- **ALTERNATE WET SUMMERS WITH DRY WINTER**



CONVECTIONAL RAIN



OFF SHORE TRADES

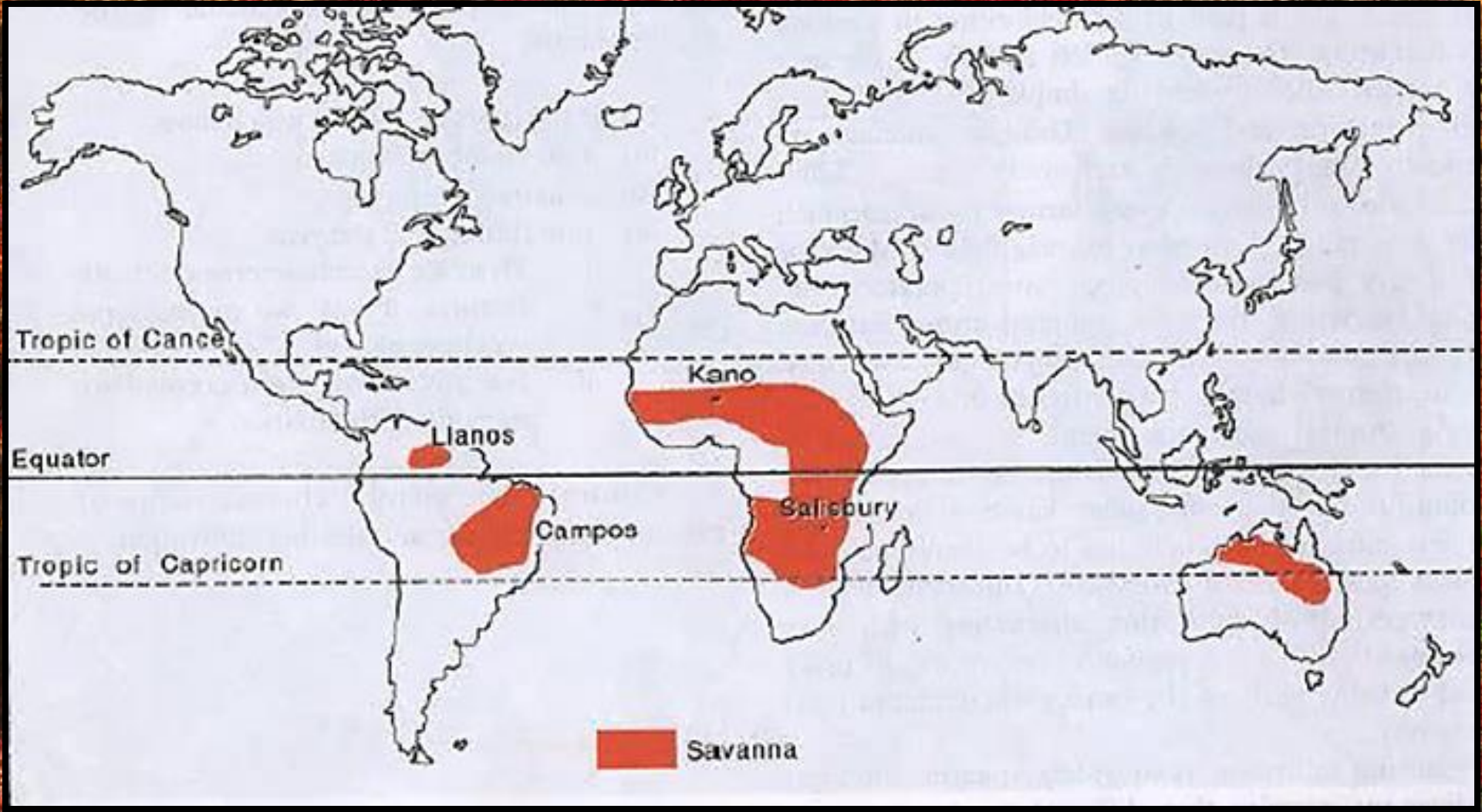
- **FLOODS AND DROUGHTS**
- **EXTREME DIURNAL RANGE OF TEMPERATURE**
- **HARMATTAN**

VEGETATION

- **TALL GRASS AND SHORT TREES
(TROPICAL GRASS LAND)**



- **BELT INCLUDES WEST AFRICAN SUDAN, SOUTHWARDS INTO EAST AFRICA, SOUTHERN AFRICA NORTH OF THE TROPIC OF CAPRICORN**
- **LLANOS OF THE ORINOCO BASIN AND THE CAMPOS OF THE BRAZILIAN HIGHLANDS IN SOUTH AMERICA**
- **ANNUAL RATE OF TEMPERATURE IS 3⁰C AND 8⁰C**
- **AVERAGE ANNUAL RAINFALL RANGES BETWEEN 100 cm AND 150 cm .**
- **LANDSCAPE ALSO KNOWN AS 'PARKLAND' OR 'BUSH-VELD'**
- **AGRICULTURE IS NOT MUCH DEVELOPED**



HOT DESERT AND MID-LATITUDE DESERT CLIMATE

- SCARCITY OF WATER
- EFFECTIVE PRECIPITATION
- HIGH DIURNAL RANGE OF TEMPERATURE
- FROST FORMATION
- NO COLD SEASON

HOT DESERTS

- OFF SHORE TRADE WINDS
- COLD OCEANIC CURRENTS

EXAMPLES : ATACAMA DESERT, PERU AND CHILE

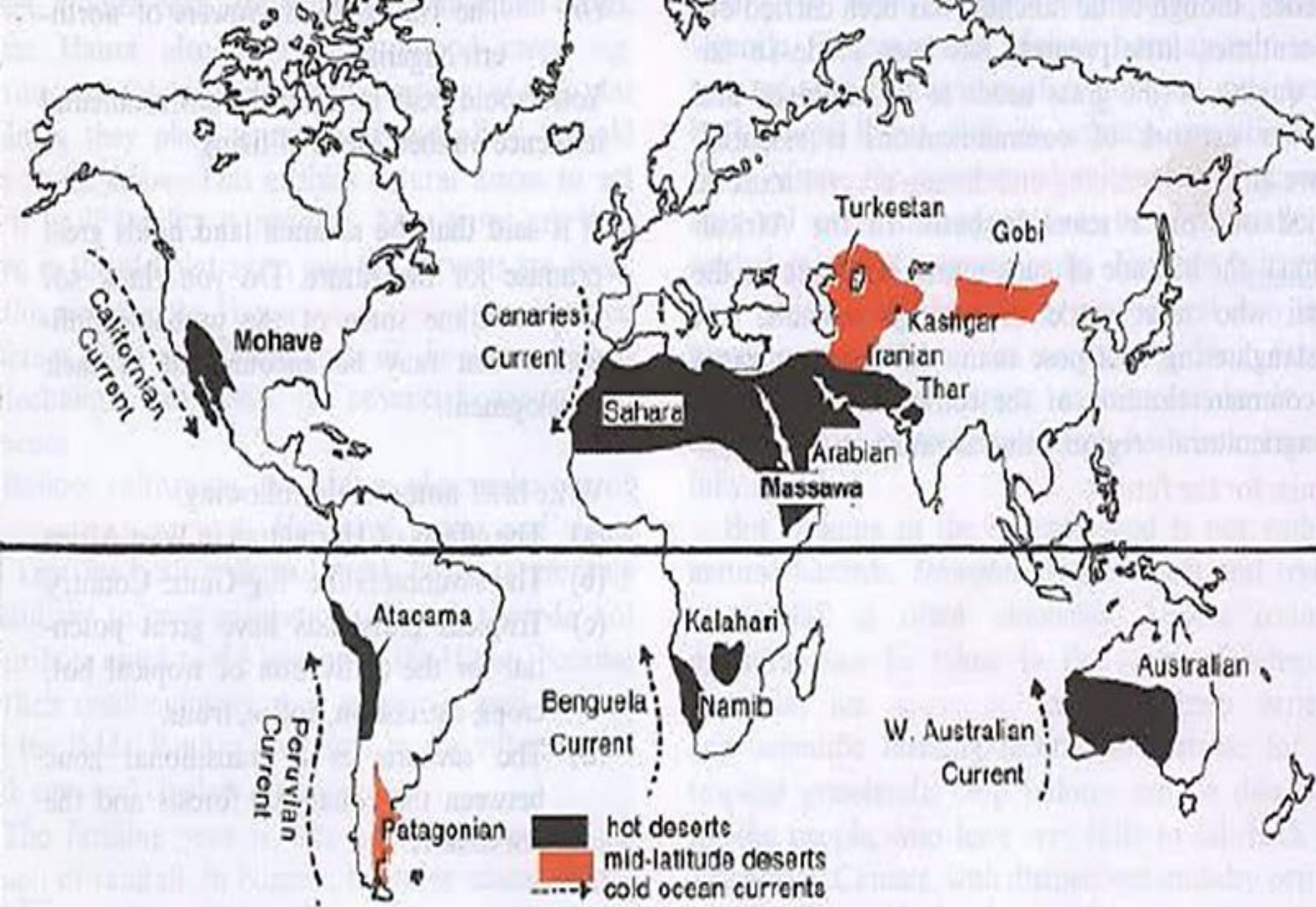
- SUBSIDING AIR

MID LATITUDE DESERTS

- INTERIOR LOCATION(LADAKH, TURKESTAN, TAKLIMAKAN, GOBI)
- RAIN SHADOW REGION



- THE WESTERN COASTS OF CONTINENTS BETWEEN 15° - 30° N AND S LATITUDES(SAHARA DESERT, GREAT AUSTRALIAN DESERT, ARABIAN DESERT, IRANIAN DESERT, THAR DESERT, KALAHARI AND NAMIB DESERTS).
- NORTH AMERICA: EXTENDS FROM MEXICO TO USA (MOHAVE SONORAN, CALIFORNIAN AND MEXICAN DESERTS)
- SOUTH AMERICA : (ATACAMA OR PERUVIAN DESERT,PATAGONIAN DESERT)
- ANNUAL PRECIPITATION MORE THAN 0.02- 10 INCHES.
- AVERAGE SUMMER TEMPERATURE 30° C.
- PREDOMINANT VEGETATION: XEROPHYTES OR DROUGHT RESISTANT SHRUB- BULBOUS CACTI, THORNY BUSHES, LONG ROOT WIRY GRASSES AND SCATTERED DWARF ACACIA. SOME FORM OF VEGETATION: GRASS SHRUB, HERBS, WEEDS, ROOTS OR BULBS ETC.

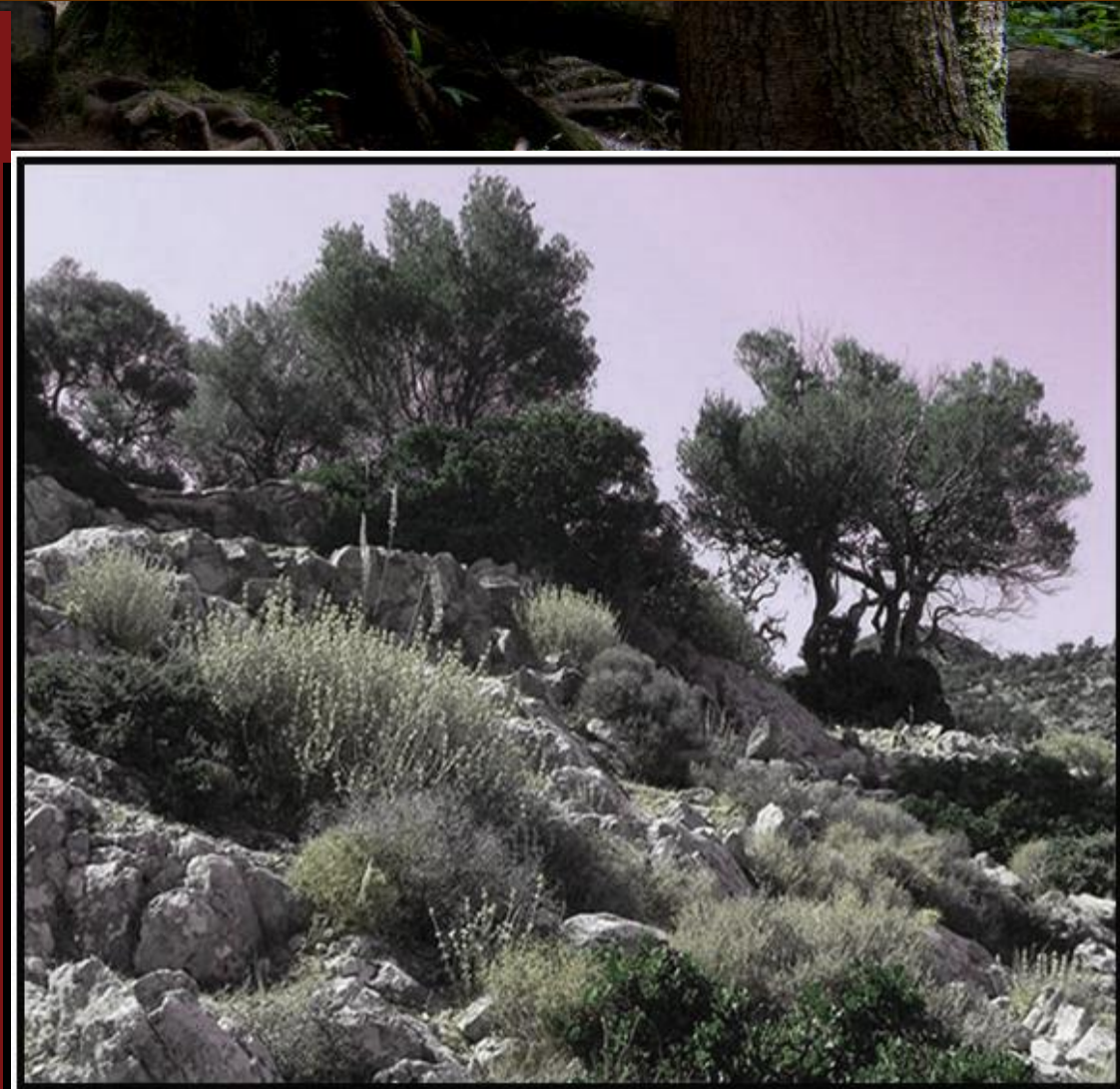


MEDITERRANEAN CLIMATE

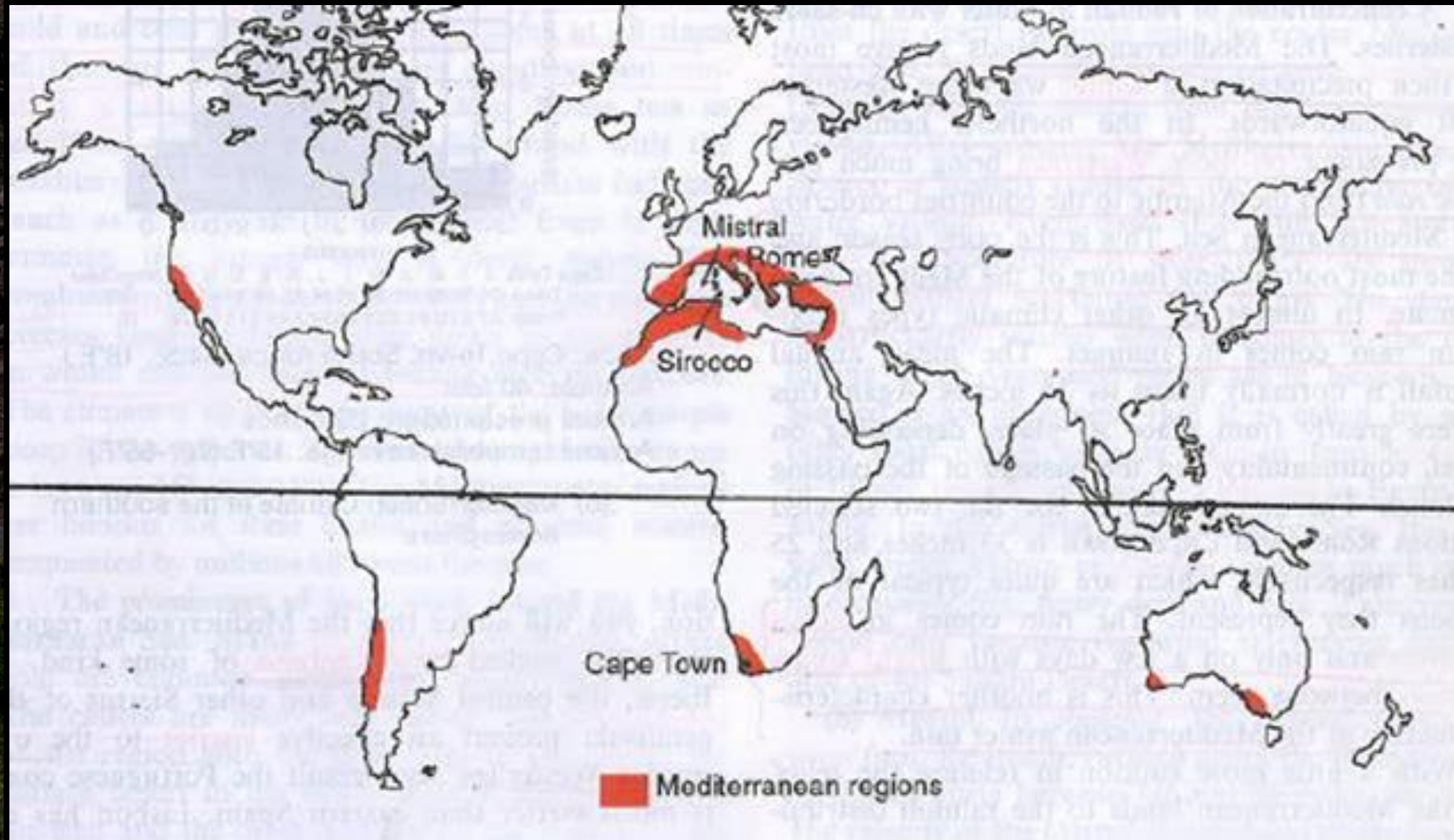
- WESTERN PORTION OF CONTINENTAL MASSES (30°-45°)
- SHIFTING OF WIND BELTS
- WINTER RAINFALL
- TRANSITIONAL CLIMATE
 - TOWARDS NORTH, COOL TEMPERATE MARITIME CLIMATE
 - TOWARDS SOUTH, TRADE WIND HOT DESERTS
- DRY WARM SUMMER WITH OFF-SHORE TRADERS; WINTER RAINFALL WITH ON-SHORE WESTERLIES; PROMINENCE OF LOCAL WINDS (SIROCCO, MISTRAL, BORA);

VEGETATION

- XEROPHYTIC SHRUBS



- **DISTRIBUTION:** Confined To The Western Portion Of Continental Masses, 30°–40°n And S Of The Equator.
- **MEDITERRANEAN REGIONS:** California, South-western Tip Of Africa, Southern Australia And Southwest Australia.
- **CLIMATIC FEATURES:** Bright, Sunny Weather With Hot Dry Summers And Wet, Mild Winters With Prominence Of Local Winds (Sirocco, mistral).
- **VEGETATION:** Citrus Fruits Such As Oranges, Lemons, Limes, Citrons, Grapefruit Etc.



STEPPE CLIMATE

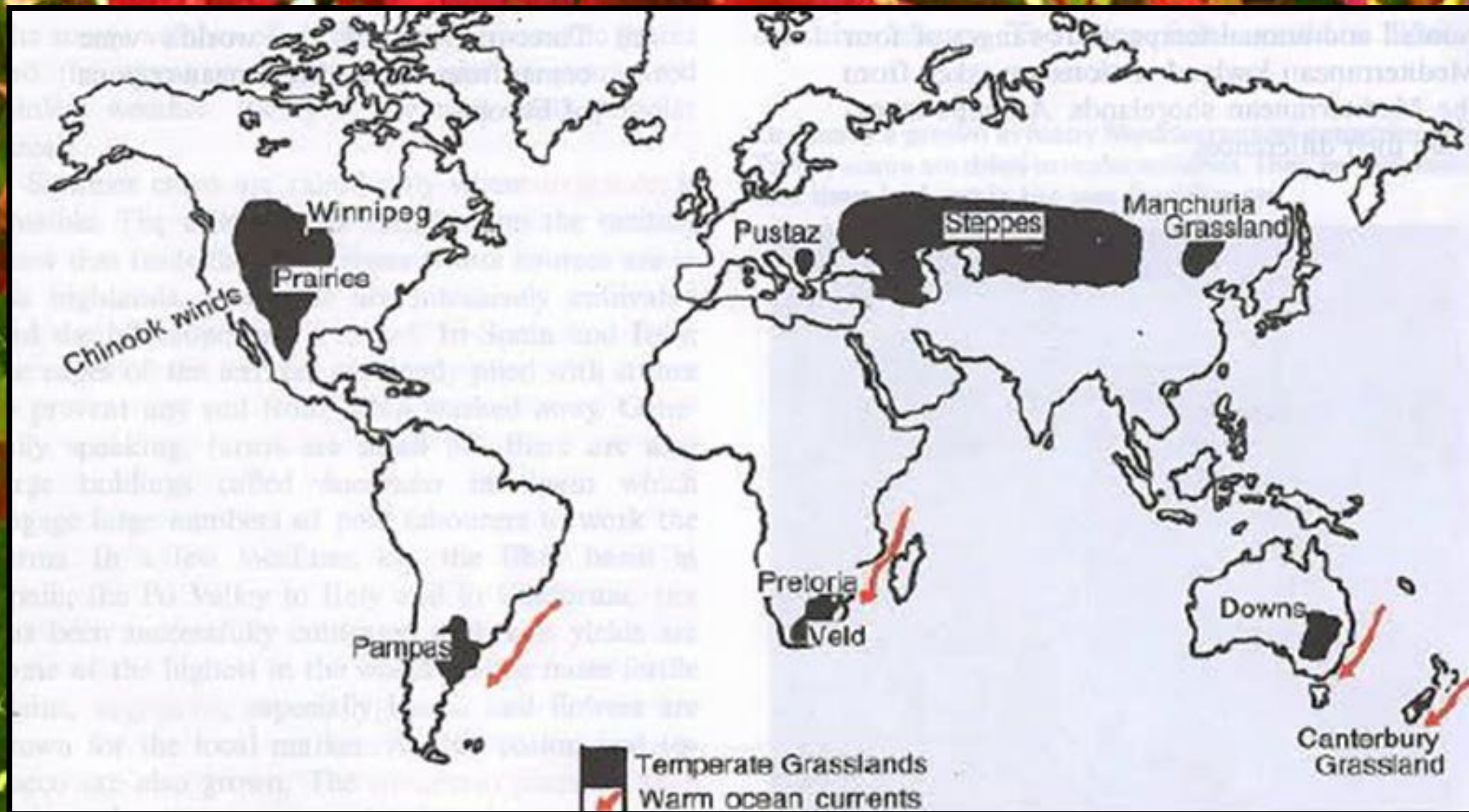
- EURASSIA- STEPPES; NORTH AMERICA- PRAIRIES
- DEEP INTERIOR POSITIONS, MOUNTAIN BARRIERS
- MEARGE AND UNRELIABLE PRECIPITATION
- NORTHERN HEMISPHERE
 - SUMMERS VERY WARM
 - WINTERS VERY COLD
- SOUTHERN HEMISPHERE
 - NEVER SEVERE (MARITIME INFLUENCE)

VEGETATION

- TEMPERATE GRASSLANDS

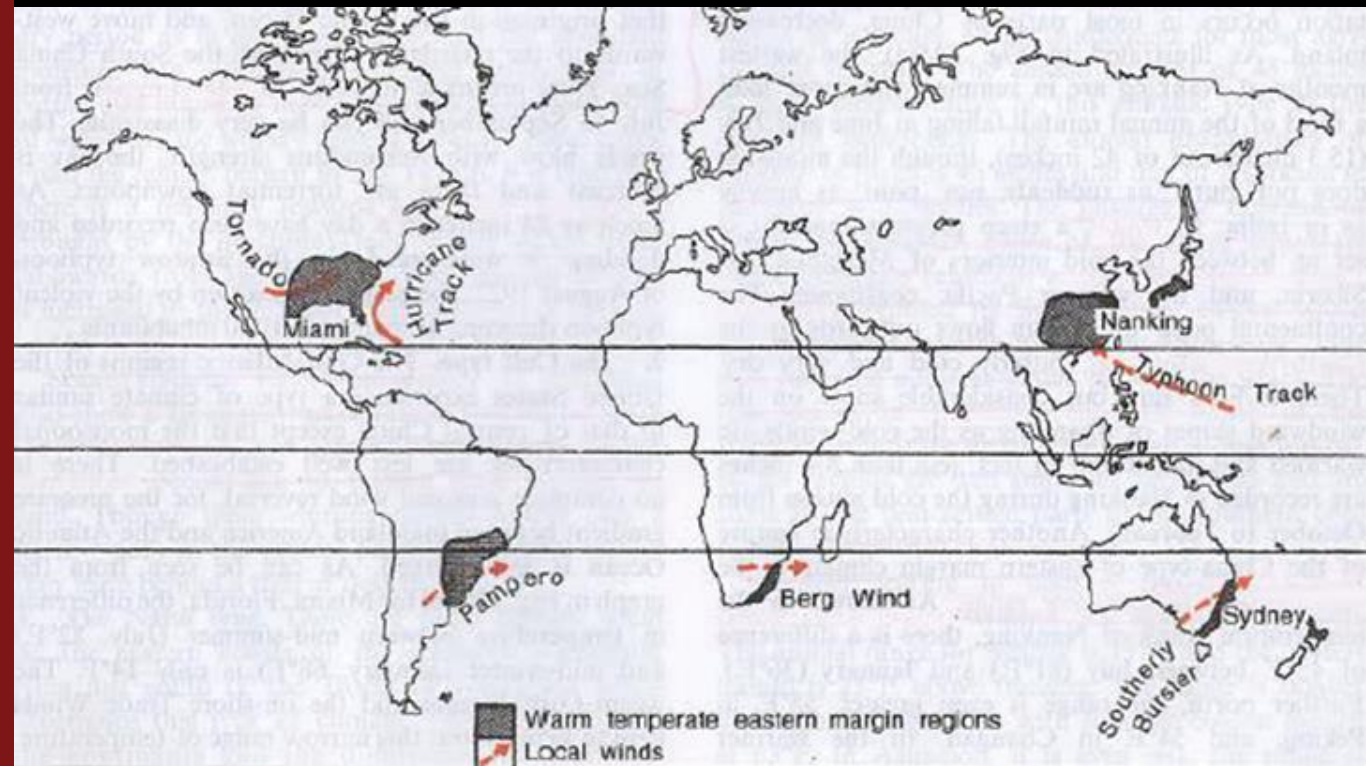


- **DISTRIBUTION:** Grasslands Are More Extensive.
- IN EURASSIA GRASSLANDS ARE CALLED AS **STEPPES**, NORTH AMERICA-**PRAIRIES**, ARGENTINA AND URUGUAY-**PAMPAS**, SOUTH AFRICA- **VELD**.
- **CLIMATE:** Summers Are Very Warm Over 19⁰c. Winters Are Very Cold.
- **AVERAGE RAINFALL-20 INCHES.**



CHINA TYPE CLIMATE

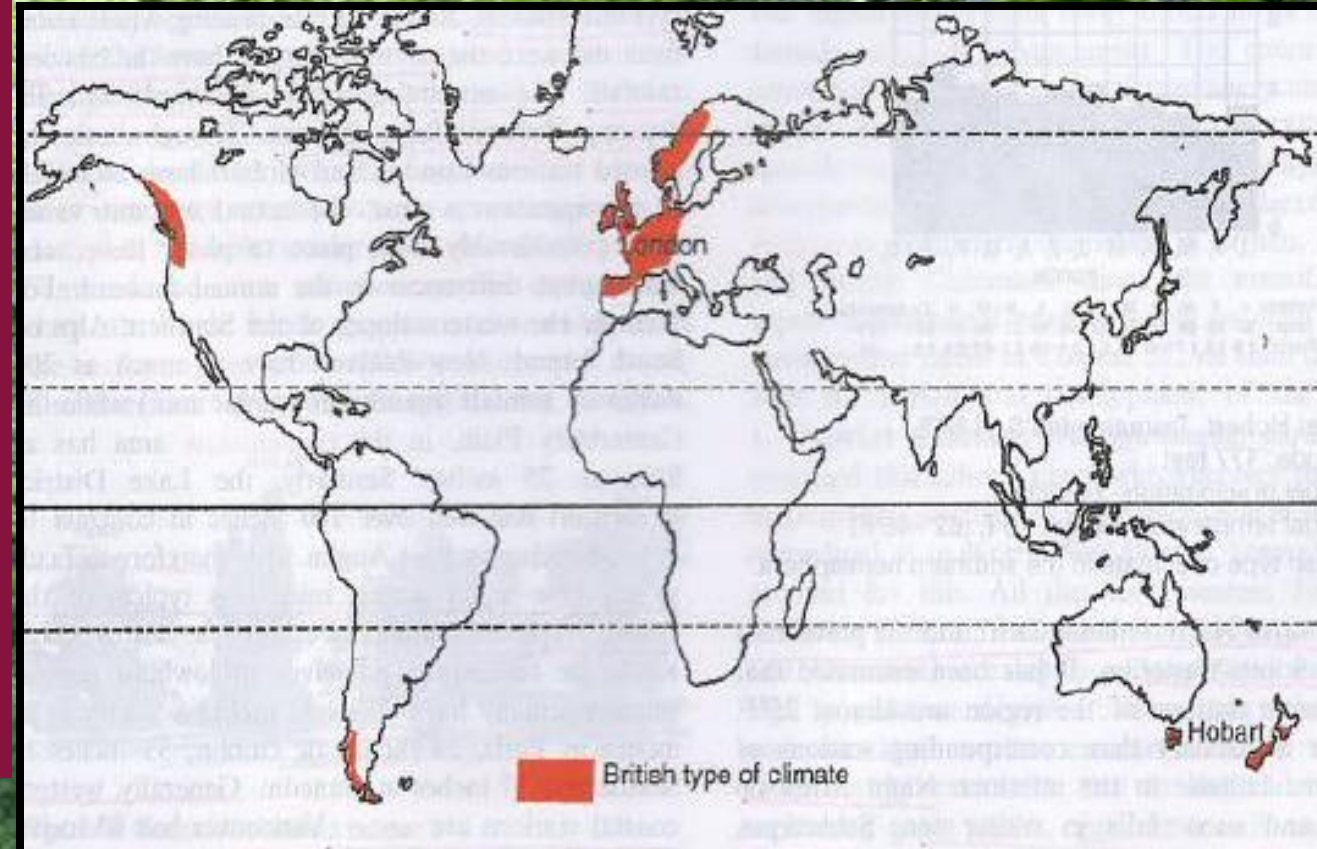
- Eastern margins of continents between 25° and 45°
- Gulf & Natal Type Climate
- Rainfall mainly in the summer (more than the Mediterranean climate)
- Typhoons



- **DISTRIBUTION:** China, Japan, South-eastern Usa, Gulf Of Mexico, New South Wales, Parana, Paraguay, Uruguay, Argentina, Natal, Australia.
- **CLIMATIC CONDITION:** Warm Moist Summer And Cool, Dry Winter.
- **AVERAGE TEMPERATURE** 5⁰- 24⁰ C.
- **RAINFALL** 25-60 INCHES.
- **VEGETATION:** Evergreen Broad -Leaved Forest And Deciduous Tree, Conifers Etc.

BRITISH TYPE CLIMATE

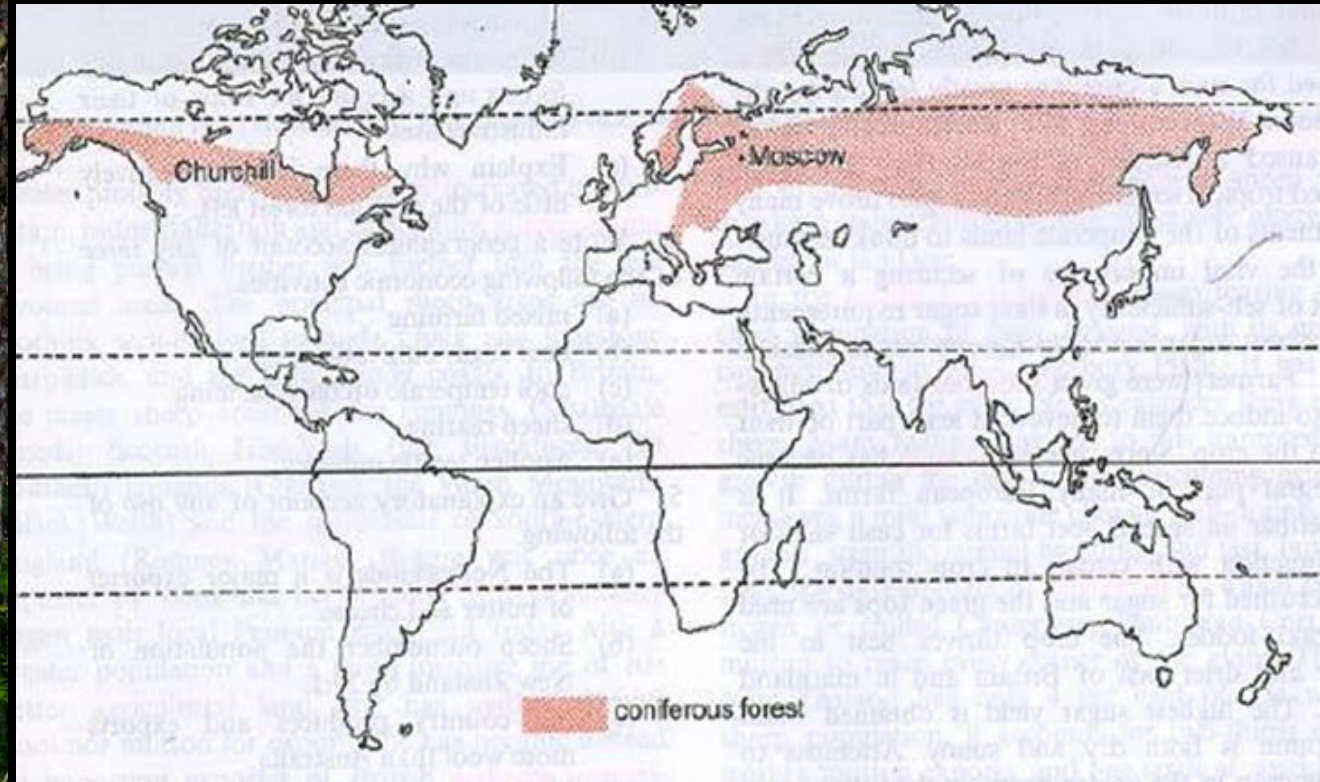
- Under the permanent influence of the Westerlies
- Oceanic influence
- cyclonic activity
- Summers are never very warm
- winters are abnormally mild



- **DISTRIBUTION:** Britain, Northern And Western France, Belgium, Netherlands, Denmark, Western Norway North- Western Iberia., Southern Chile, Tasmania, New Zealand.
- **CLIMATIC CONDITION:** Average Annual Temperature 5°-15°C.
- **ADEQUATE RAINFALL THROUGHOUT THE YEAR.**
- **VEGETATION:** Deciduous Forest, Oak, Elm, Ash, Birch, Beech, Poplar, Hornbeam Etc.

SIBERIAN CLIMATE

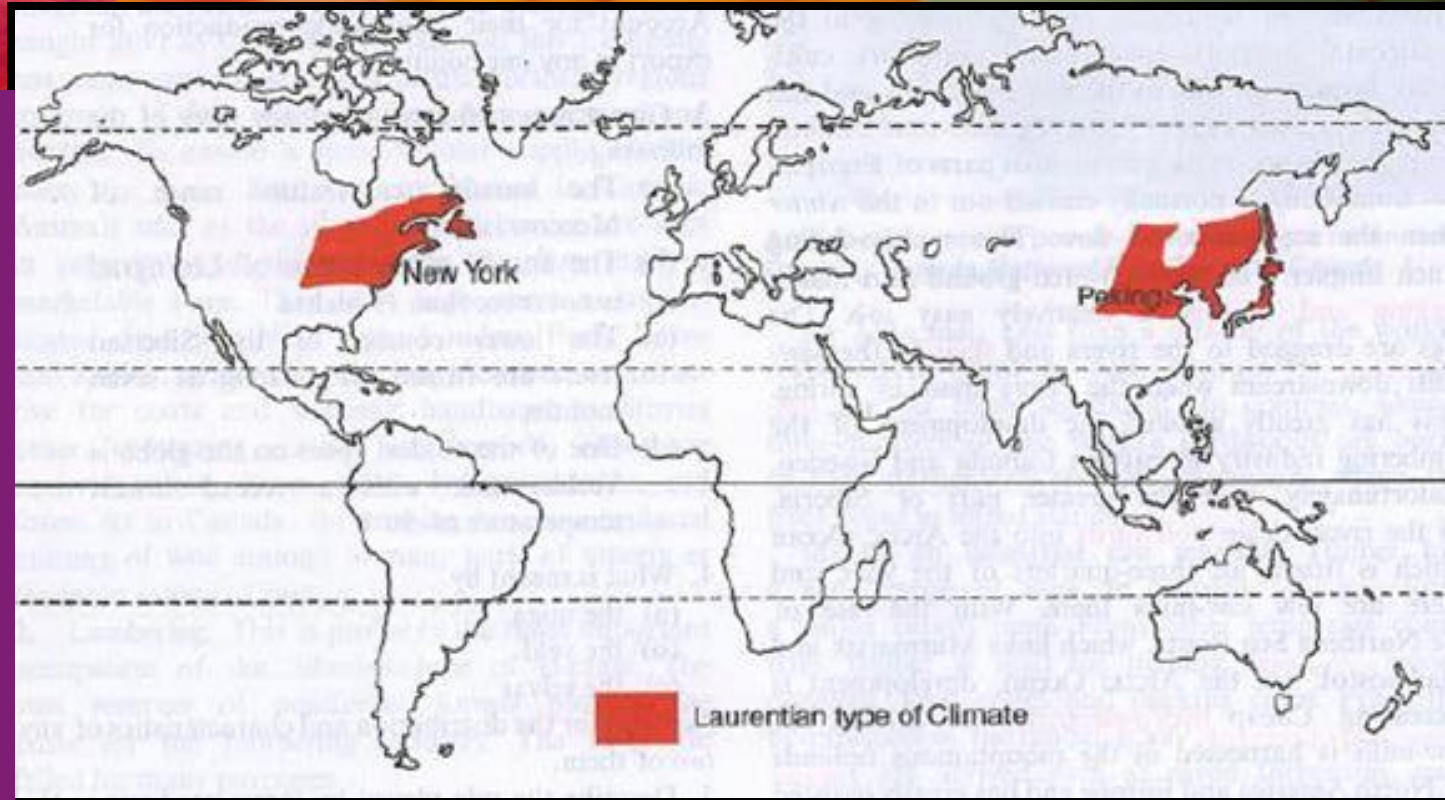
- Only in the northern hemisphere in high latitudes
- Evergreen coniferous forest (Taiga)
- Absent in the southern hemisphere
- Long cold winter
- Summers are short
- Precipitation is low



- **DISTRIBUTION: Eurasia, North America.**
- **CLIMATIC CONDITION: Bitterly Cold Winter Of Long Duration And A Cool Brief Summer.**
- **AVERAGE ANNUAL TEMPERATURE 5⁰- 15⁰ C.**
- **ANNUAL RAINFALL 15-25 INCHES**
- **VEGETATION: Coniferous Forest.**

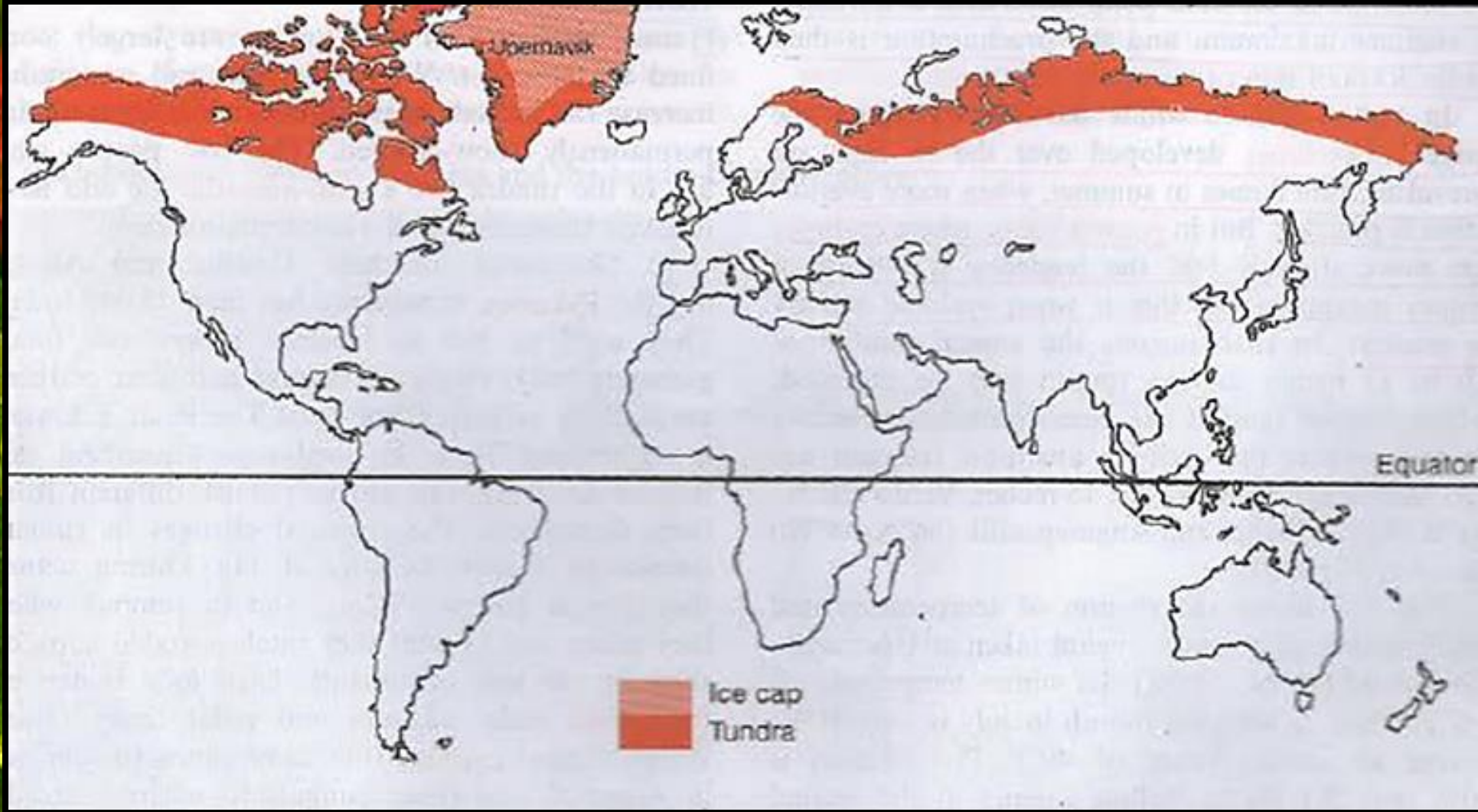
LAURENTIAN CLIMATE

- Intermediate type of climate between the **British** and the **Siberian** type of climate
- Cold dry winter and warm wet summer
- Rainfall high in summer

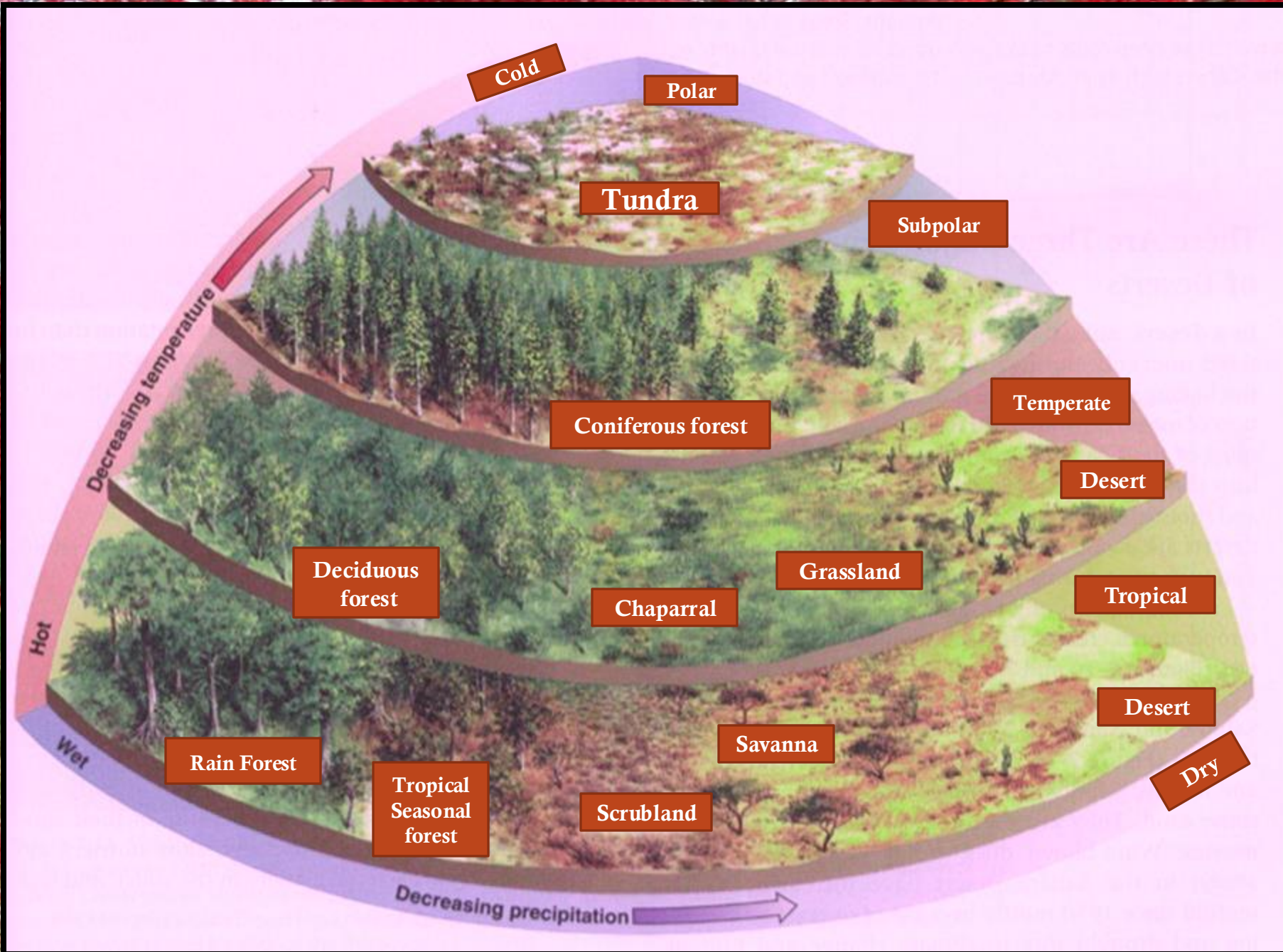


- **DISTRIBUTION:** North-eastern North America, Eastern Canada, North-east U.S.A. Newfoundland, Eastern Siberia, North China, Manchuria, Korea And Northern Japan.
- **CLIMATIC CONDITION:** Cold, dry Winters And Warm, Wet Summers.
- **SUMMER TEMPERATURE** 21⁰- 27⁰ C.
- **ANNUAL RAINFALL** 30-60 INCHES
- **VEGETATION:** OAK, BEECH, MAPLE, BIRCH ETC.

THE ARCTIC OR POLAR CLIMATE



- **DISTRIBUTION:** Arctic Circle, Greenland, Northern Canada , Alaska, Arctic Seaboard Of Eurasia.
- **CLIMATIC CONDITION:**Very Low Mean Annual Temperature (-35°) And Warmest Month(10°) In June.
- **PRECIPITATION IS MAINLY IN THE FORM OF SNOW.**
- **VEGETATION:** Mosses, Lichens, Sedges Etc.



CLIMATIC REGIONS IN INDIA



KOPPEN CLIMATE CLASSIFICATION

FIRST LETTER:

A----- TROPICAL HUMID----- LOW LATITUDE WARM + WET.

B----- DRY----- EVAPORATION IS GREATER PRECIPITATION.

C----- MILD MIDLATITUDES----- MILD WINTERS WARM/HOT SUMMER.

D----- SEVERE MIDLATITUDES---- SEVERE, COLD, WINTERS.

E----- POLAR----- VERY HIGH LATITUDES, COLD CLIMATES.

H----- HIGHLAND----- HIGH MOUNTAINS CLIMATE CONTROLLED BY ELEVATION

SECOND LETTER: (A, C & D CLIMATES)

f- WET ALL YEAR.

m- MONSOONAL SUMMERS, VERY WET SUMMER.

w- WINTER DRY SEASON.

s- SUMMERS DRY SEASON.

B CLIMATES

W----- Deserts----- Extremely arid.

S-----Steppes-----Semi-arid.

E Climates

T----- Tundra----- 1 month temperature are above freeze.

F----- Ice Caps----- All month average below freeze.

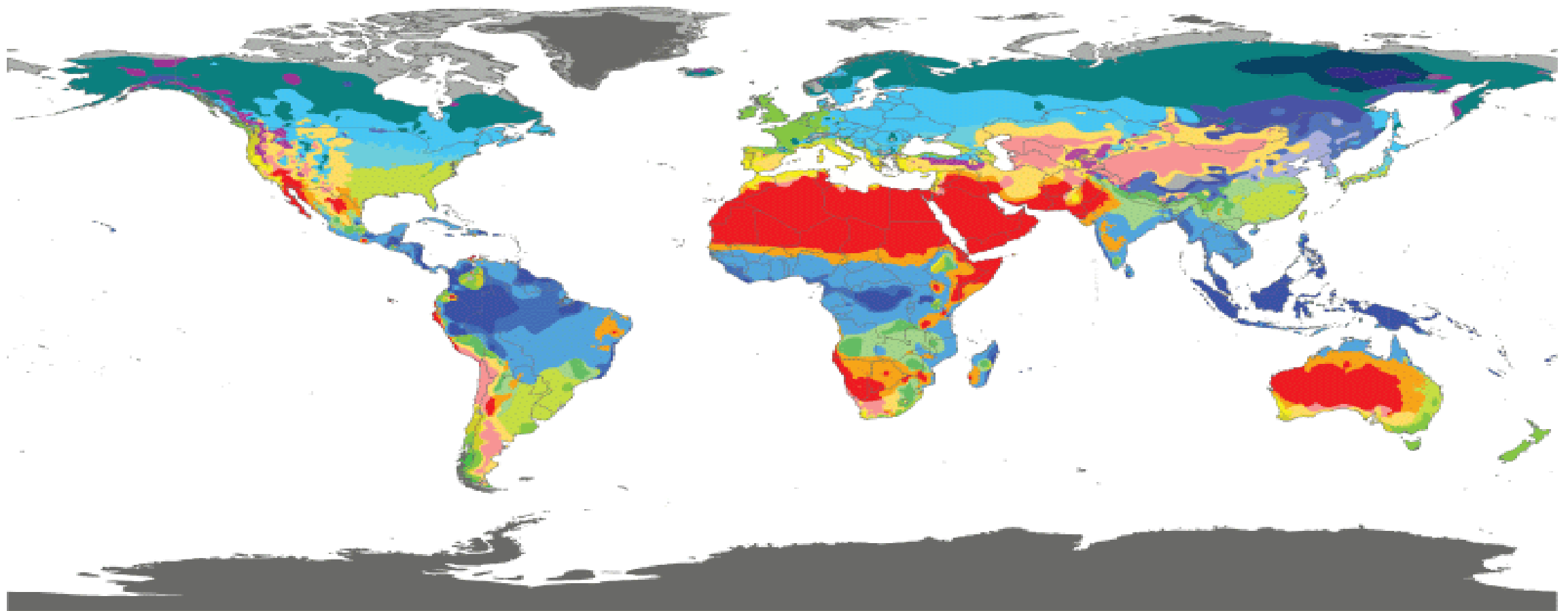
Third Letter: (C+D Climates)

- a Hot Summers
- b warm Summers
- c Cool Summers
- d Very Cold Winters

B Climates

- h Hot Desert/ Steppe
- k Cold Desert or Steppe.

World map of Köppen-Geiger climate classification



Tropical (A)		Dry (B)	Temperate (C)				Continental (D)				Polar Alpine (E)	
 Af	 BWh	 Csa	 Cwa	 Cfa	 Dsa	 Dwa	 Dfa	 ET				
 Am	 BWk	 Csb	 Cwb	 Cfb	 Dsb	 Dwb	 Dfb	 EF				
 Aw	 BSh		 Cwc	 Cfc	 Dsc	 Dwc	 Dfc					
	 BSk				 Dsd	 Dwd	 Dfd					

DATA SOURCE : GHCN v2.0 station data
Temperature (N = 4,844) and
Precipitation (N = 12,396)

PERIOD OF RECORD : All available

MIN LENGTH : ≥30 for each month.

RESOLUTION : 0.1 degree lat/long

Contact : Murray C. Peel (mpeel@unimelb.edu.au) for further information

An underwater photograph showing sunlight rays (tyndall effect) filtering through the water from the surface. The water is a deep blue color, and the light rays create a dramatic, ethereal atmosphere. The rays are most prominent in the upper right quadrant of the image.

OCEANOGRAPHY

WATER DISTRIBUTION

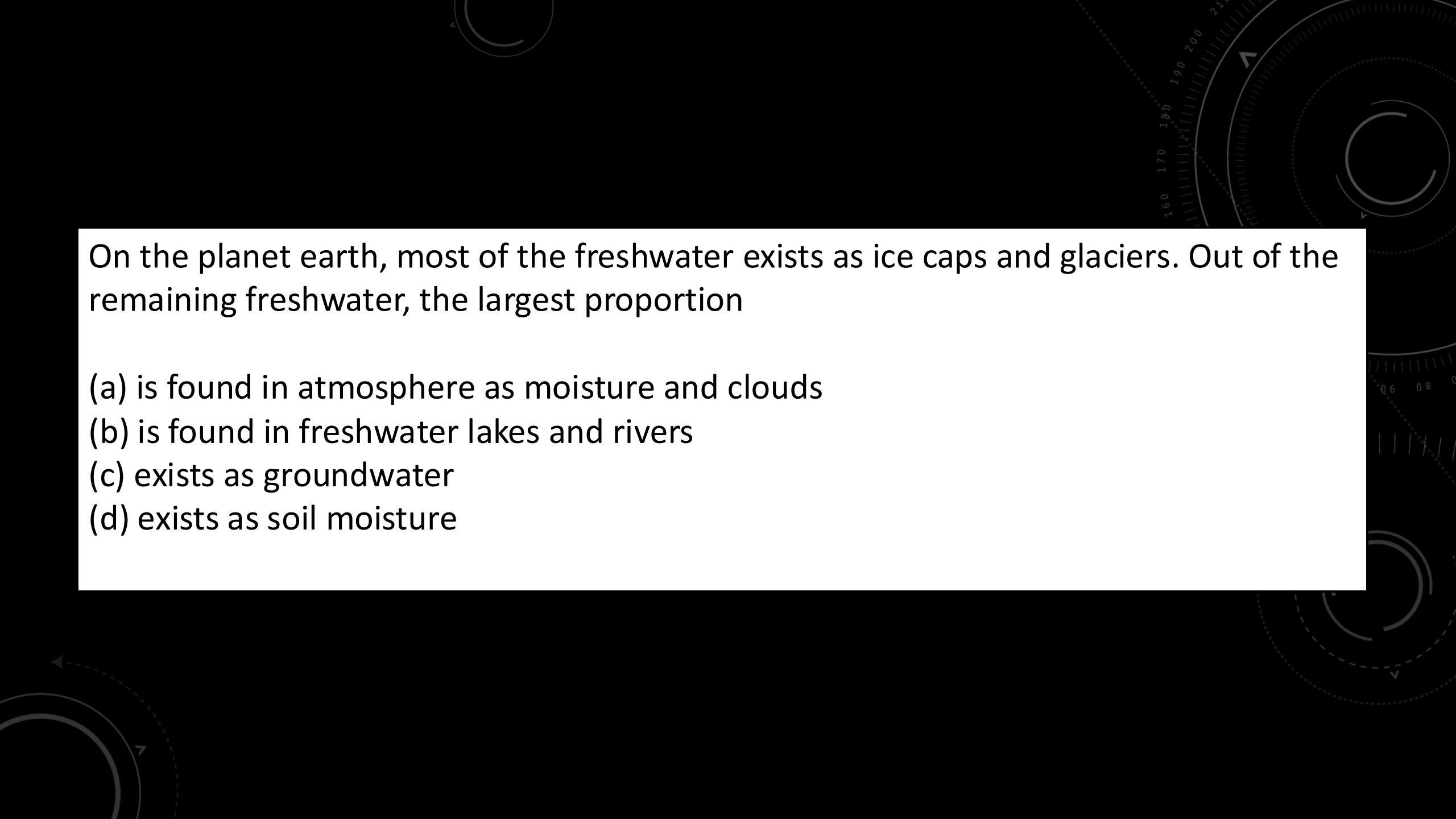
- **43 percent** lies in northern hemisphere and **57 percent** in the southern hemisphere
- **97% resides in the oceans** - **3% of water on the surface is fresh**

➤ Freshwater

- **69% resides in glaciers**
- **30% underground**
- **less than 1% is located ON surface**

➤ Usable quantity

<i>Reservoir</i>	<i>Volume (Million Cubic km)</i>	<i>Percentage of the Total</i>
Oceans	1,370	97.25
Ice Caps and Glaciers	29	2.05
Groundwater	9.5	0.68
Lakes	0.125	0.01
Soil Moisture	0.065	0.005
Atmosphere	0.013	0.001
Streams and Rivers	0.0017	0.0001
Biosphere	0.0006	0.00004

The background is dark with faint, light-colored circular patterns and numbers. On the right side, there are concentric circles with numbers 160, 170, 180, 190, 200, and 210. On the left side, there are numbers 06 and 08. There are also some dashed lines and arrows.

On the planet earth, most of the freshwater exists as ice caps and glaciers. Out of the remaining freshwater, the largest proportion

- (a) is found in atmosphere as moisture and clouds
- (b) is found in freshwater lakes and rivers
- (c) exists as groundwater
- (d) exists as soil moisture

Consider the following statements:

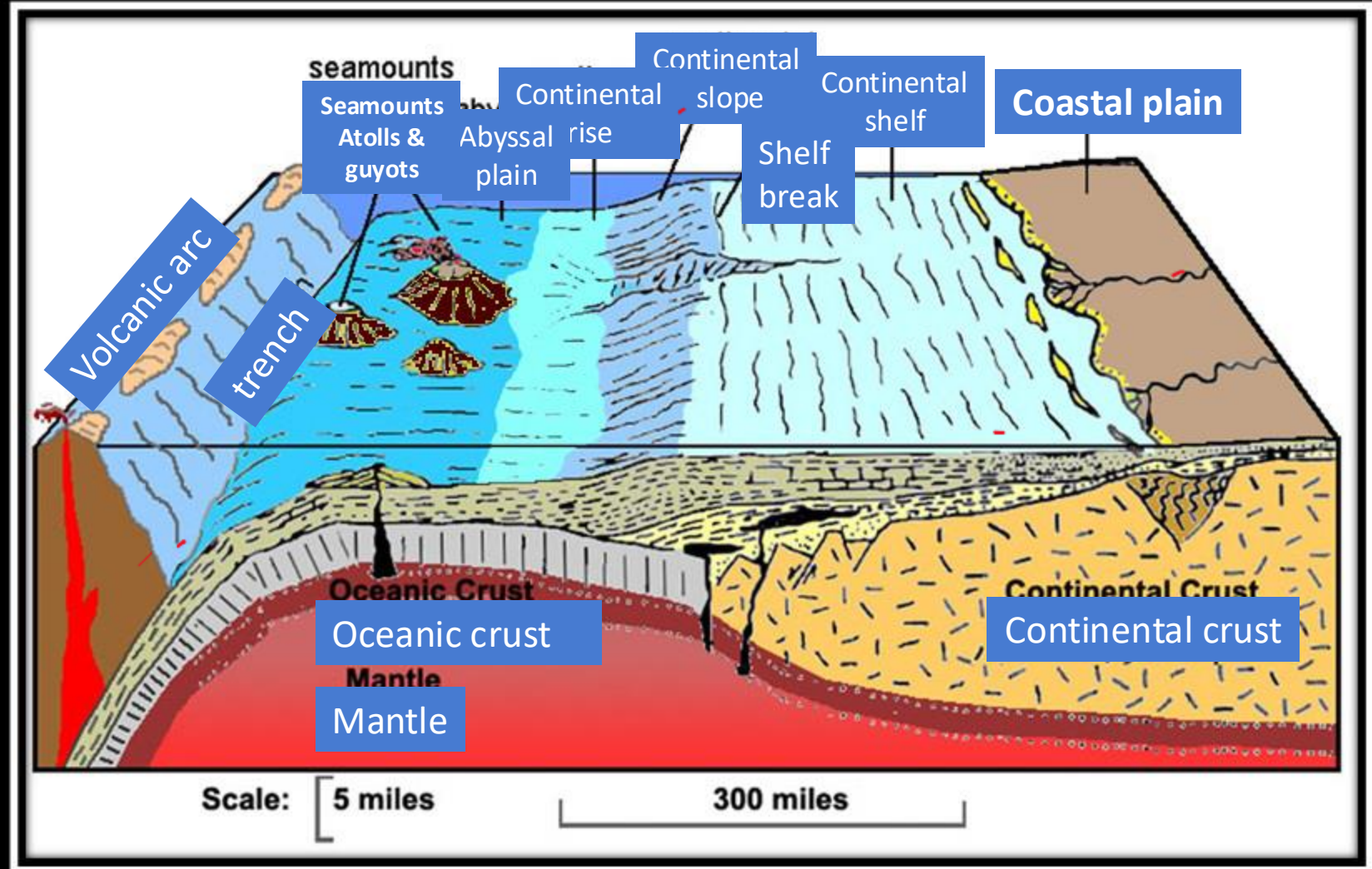
1. On the planet Earth, the fresh water available for use amounts to about less than 1% of the total water found.
2. Of the total fresh water found on planet Earth ^{69%.} 95% is bound up in polar ice caps and glaciers.

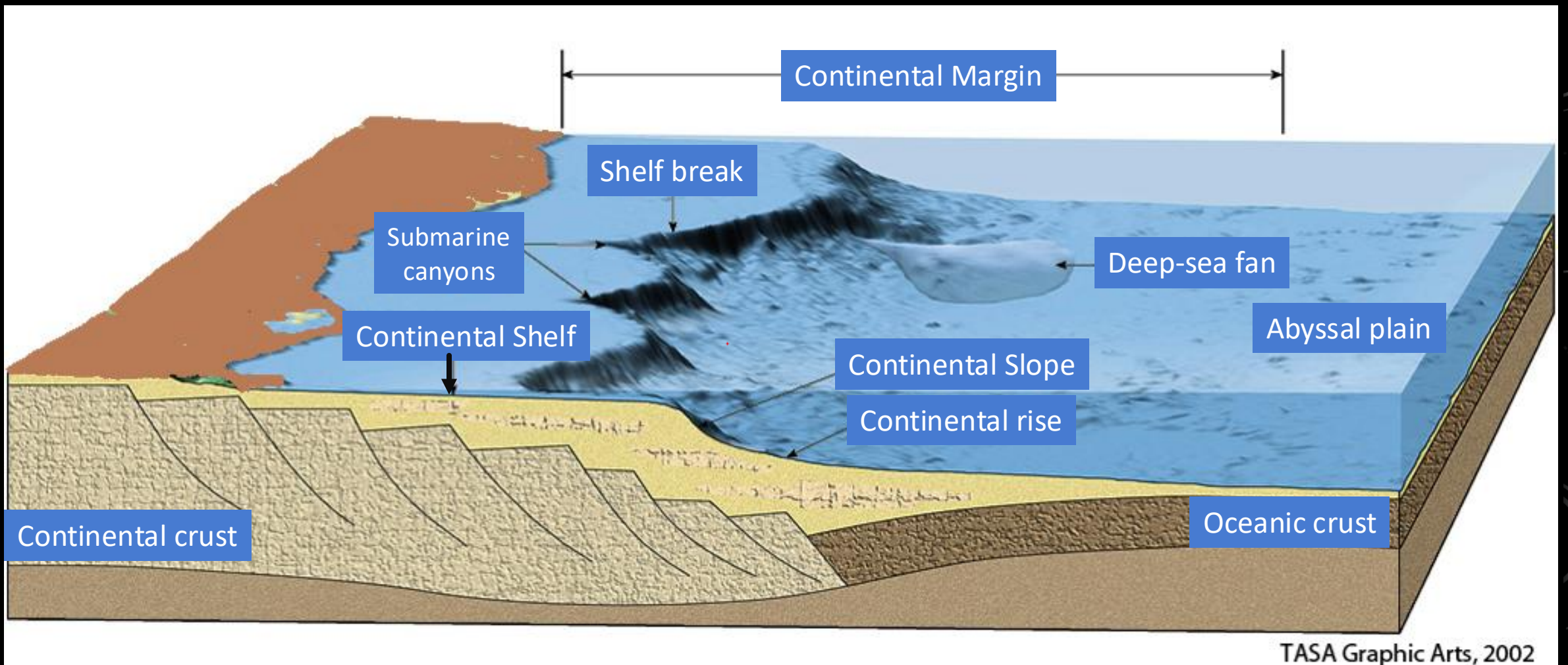
Which of the statements is given above is/are correct?

(a) 1 only (b) 2 only (c) both 1 and 2 (d) Neither 1 nor 2

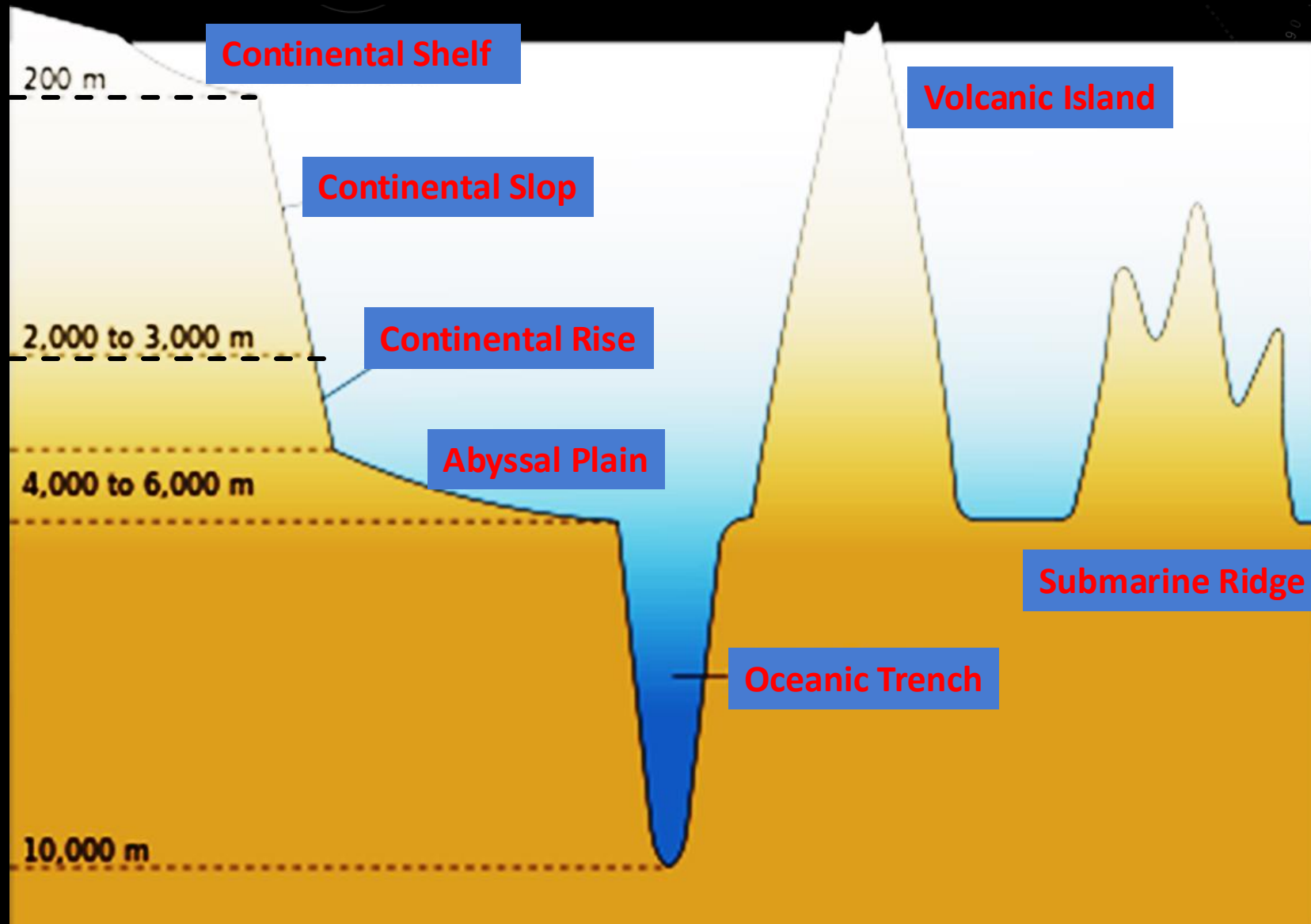
RELIEF OF THE OCEAN FLOOR

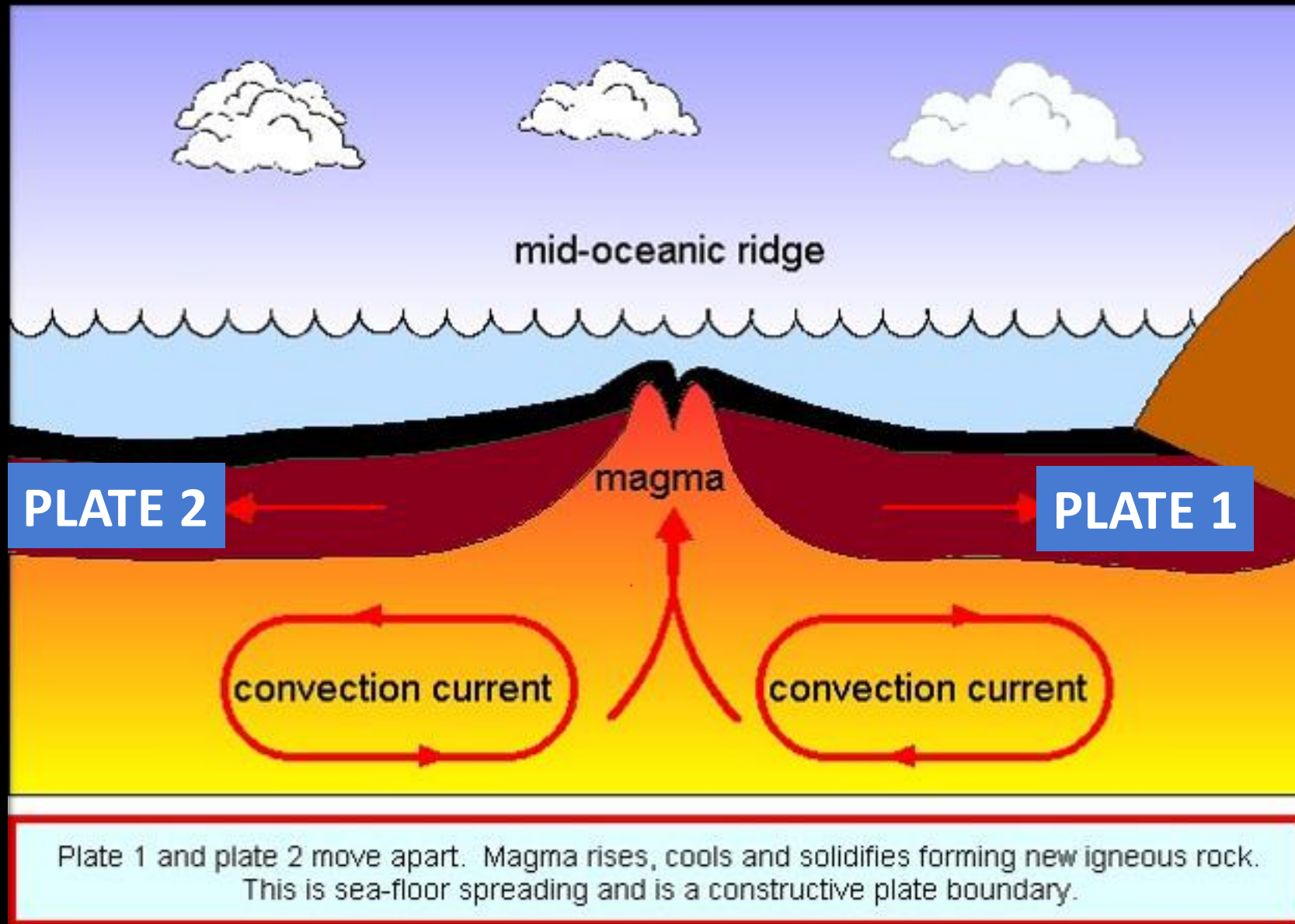
- **Continental shelf**
- **Continental slope**
- **Deep sea plain**
- **Trenches**
- **Mid-oceanic ridges**
- **Seamount**
- **Guyots**
- **Submarine canyons**
- **Atoll**





TASA Graphic Arts, 2002

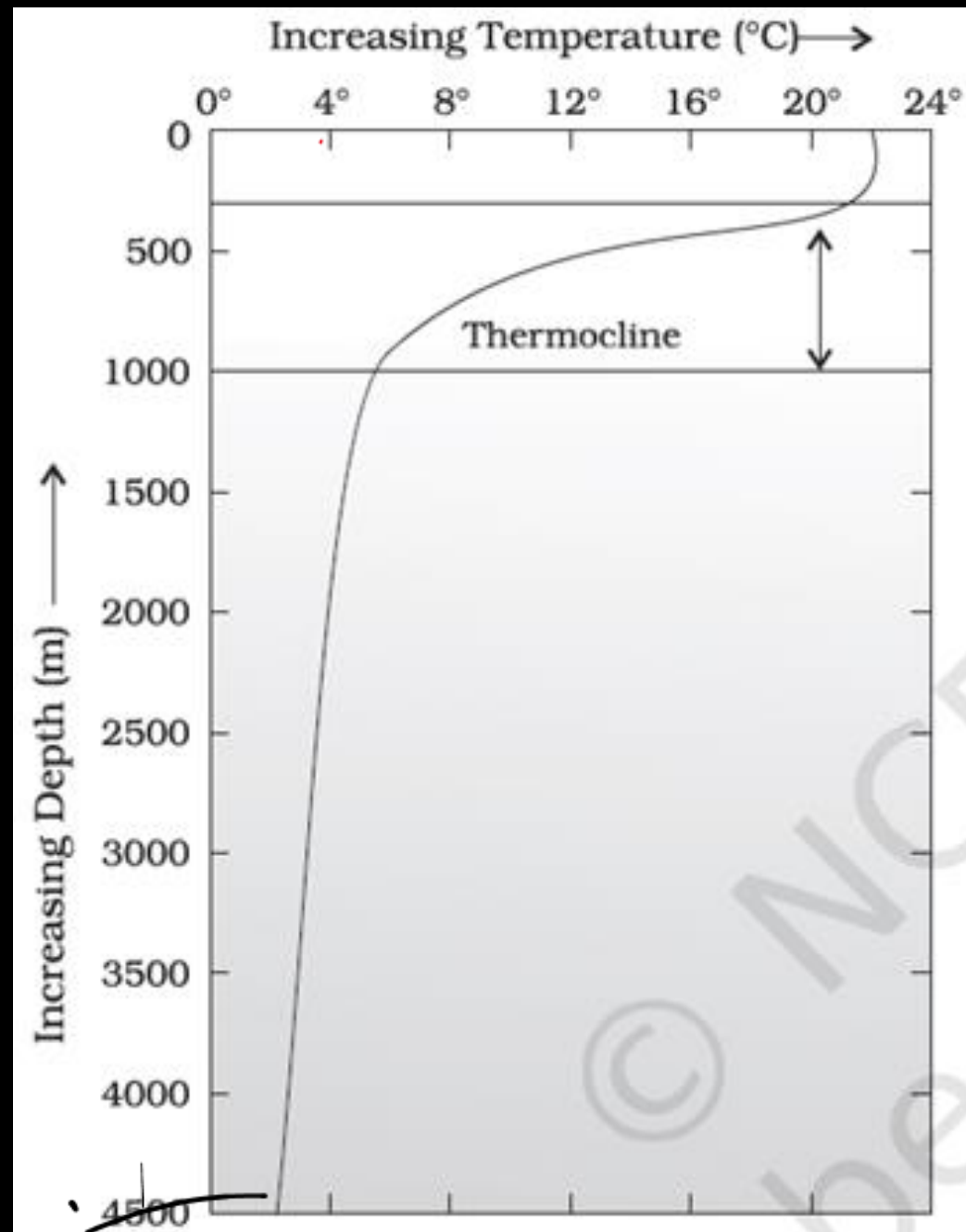


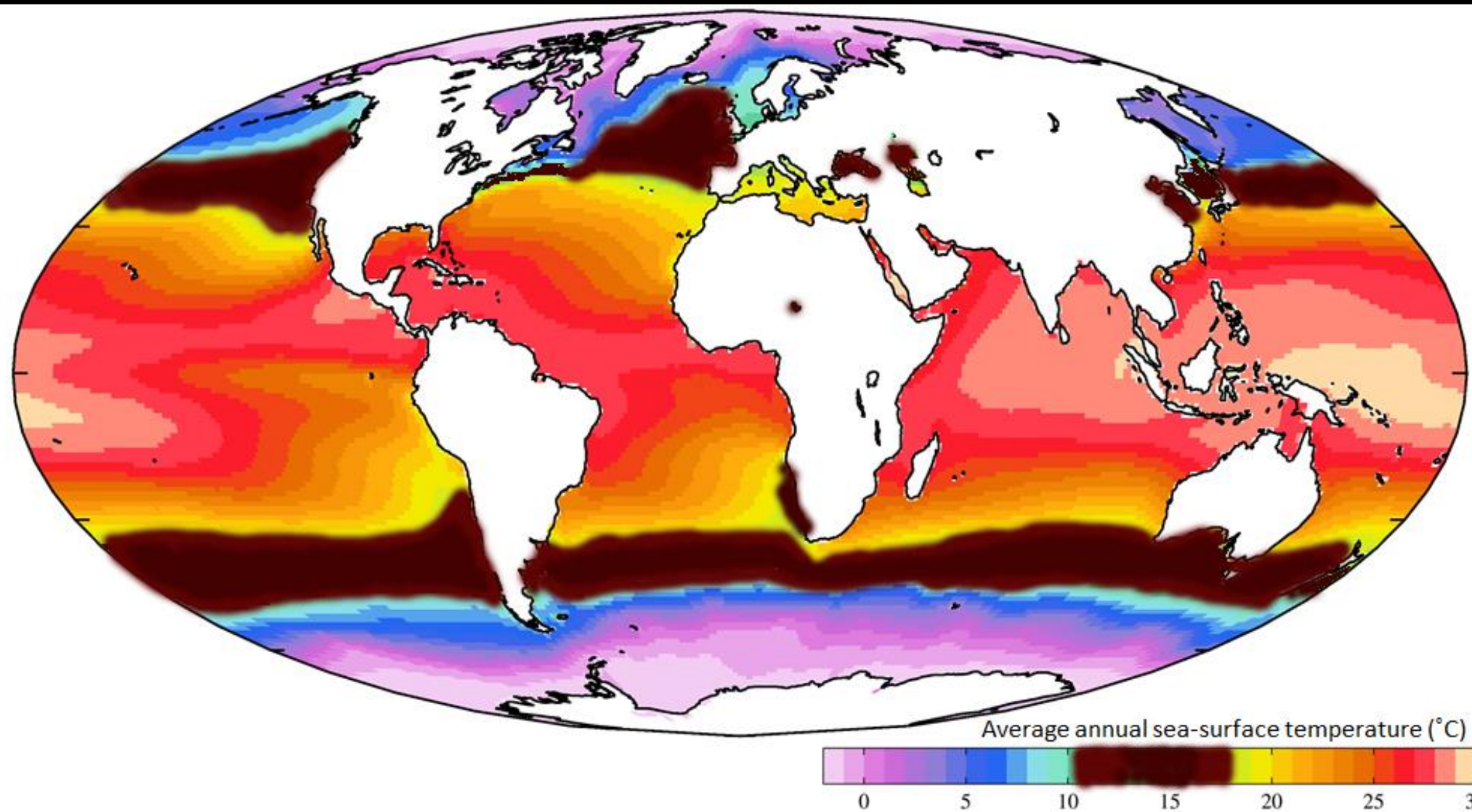


TEMPERATURE

❑ **FACTORS**

- **Latitude**
- **Unequal distribution of land and water**
- **Prevailing wind**
- **Ocean currents**



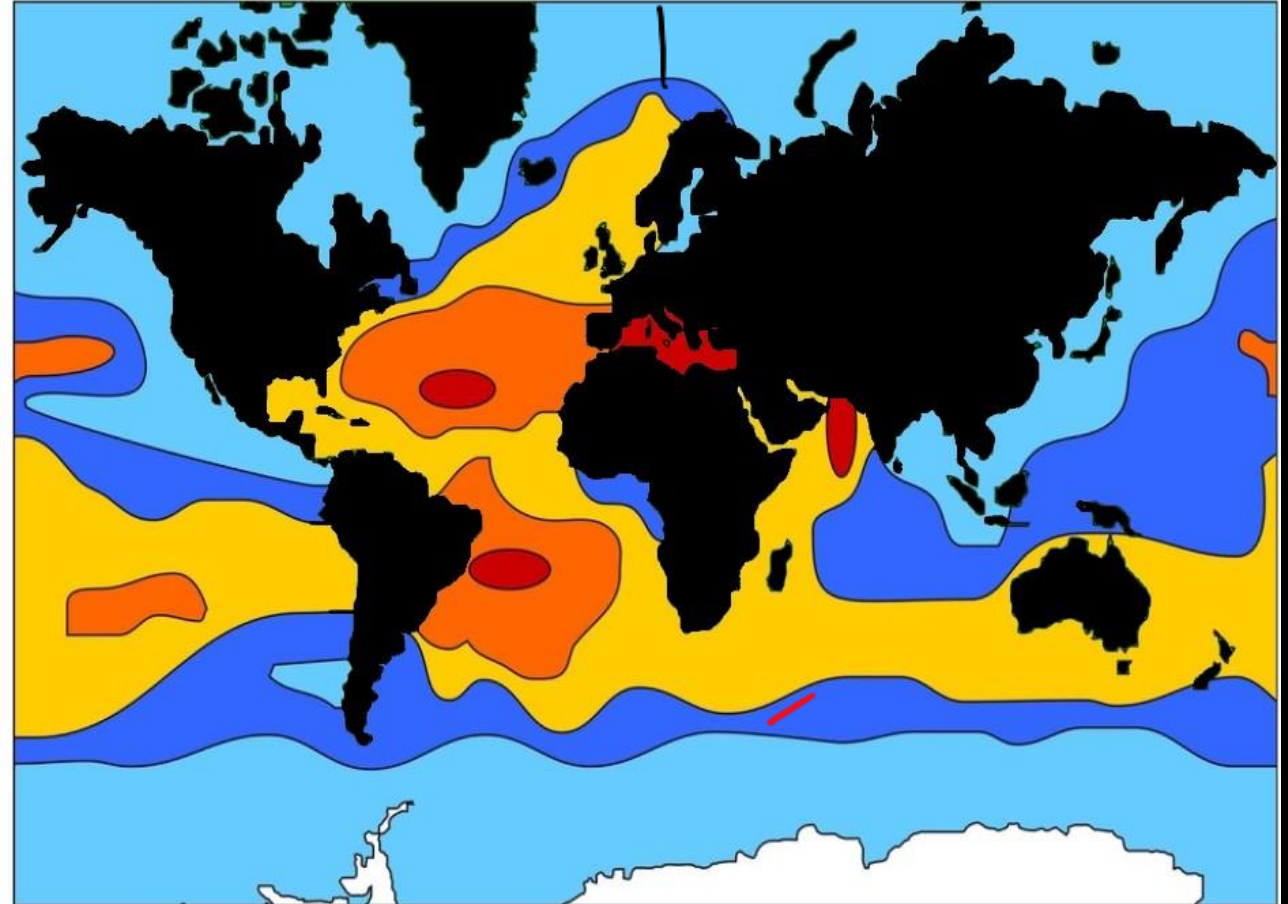
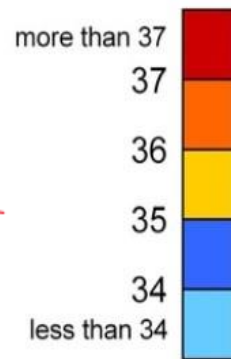


SALINITY

❑ FACTORS

- **Evaporation**
- **Precipitation**
- **River discharge**
- **Wind**
- **Ocean currents**
- **Temperature**

Salinity (ppt)



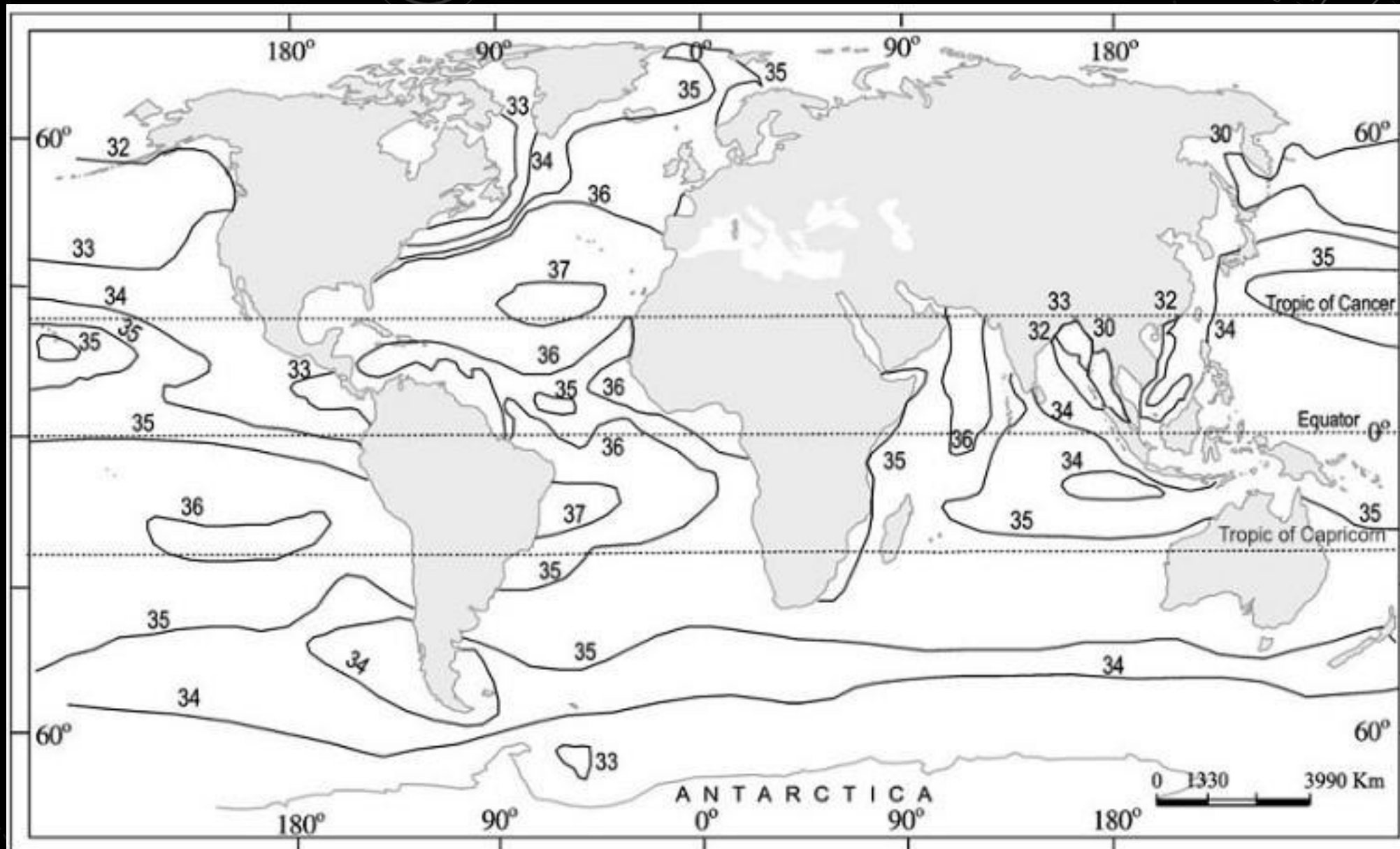
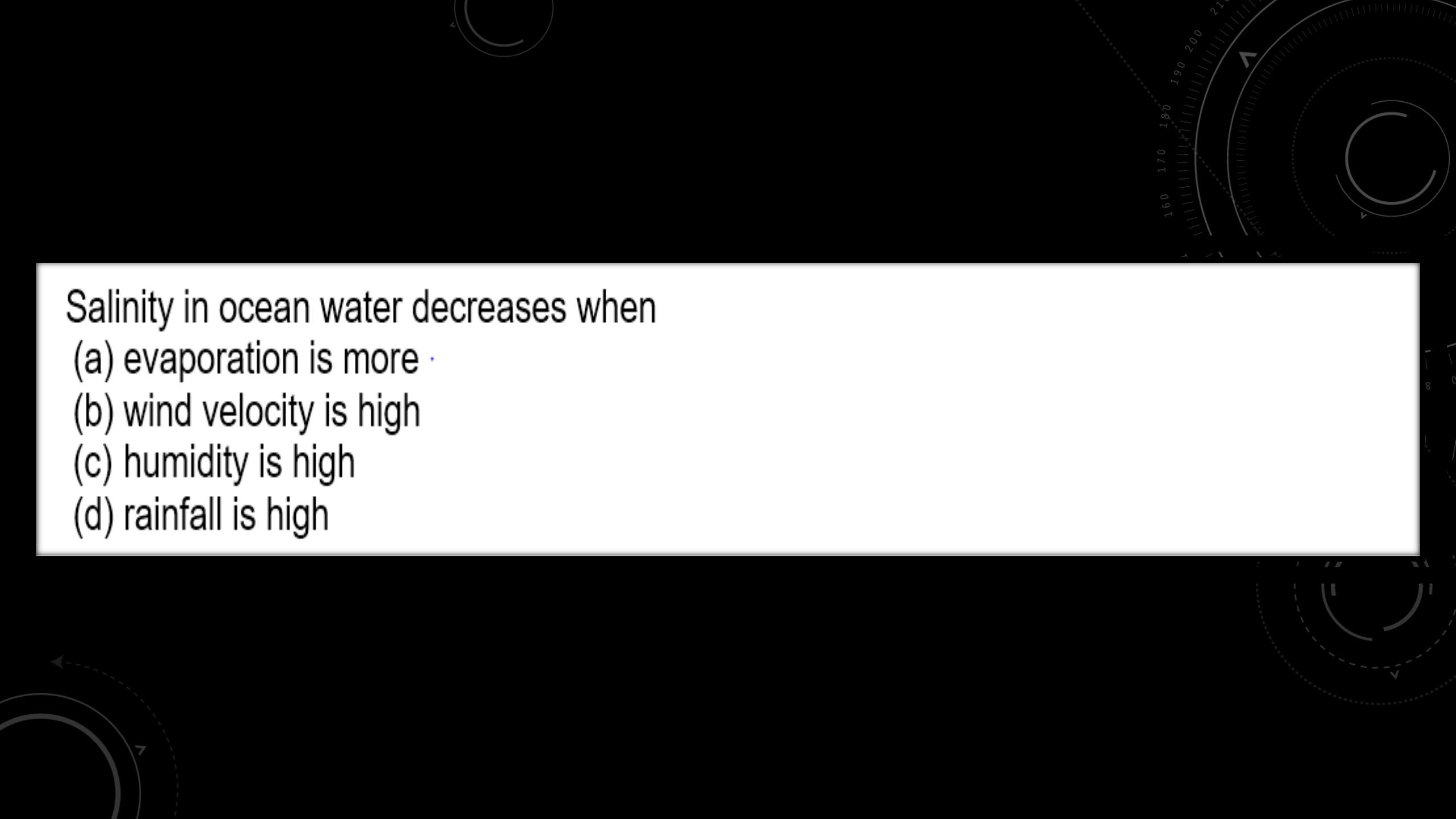


Figure 13.5 : Surface salinity of the World's Oceans

The background is dark with faint, light-colored circular patterns. On the right side, there is a scale with numbers 160, 170, 180, 190, 200, and 210. There are also some curved arrows and dashed lines, suggesting a technical or scientific theme.

Salinity in ocean water decreases when

- (a) evaporation is more
- (b) wind velocity is high
- (c) humidity is high
- (d) rainfall is high

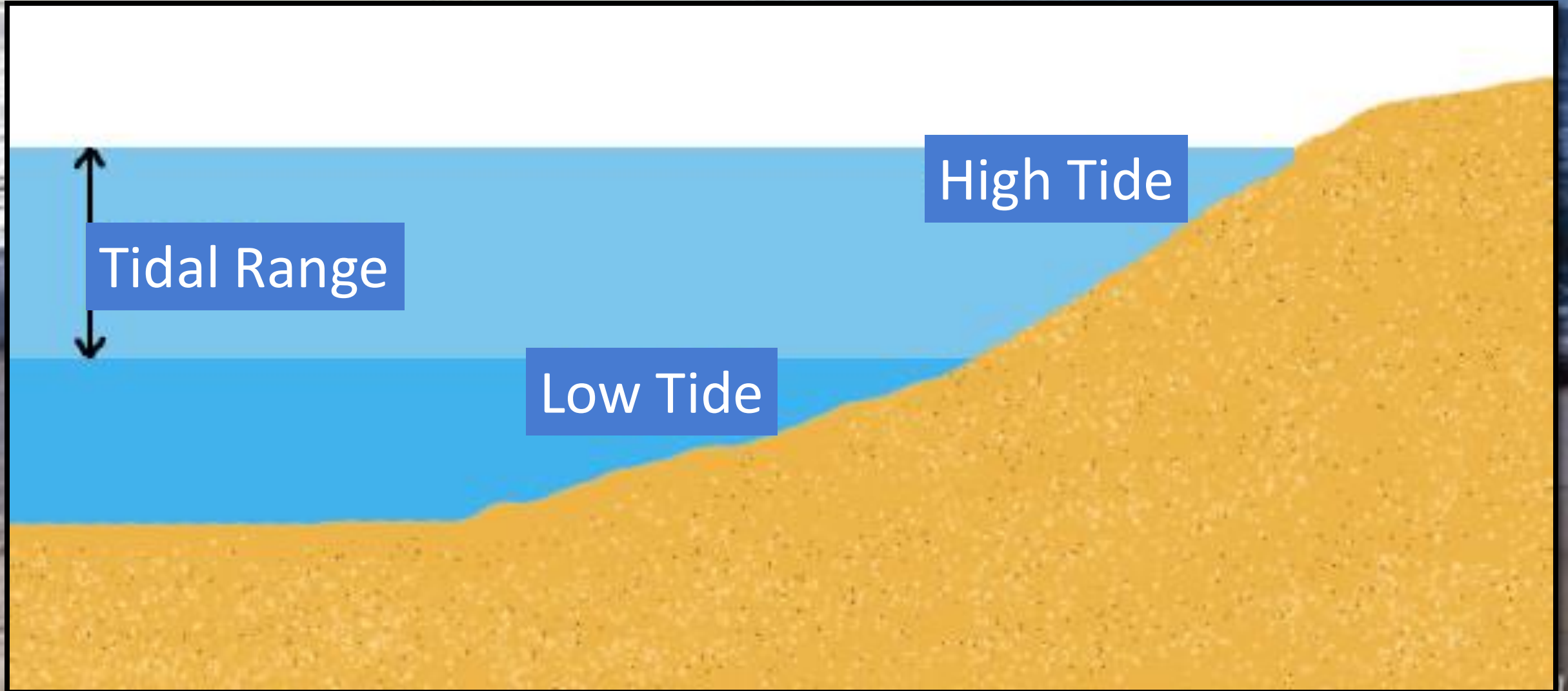
OCEAN TIDE

- **Periodic rise and fall of sea level**
- **Flood tide - Ebb tide**

☐ **FACTORS**

- **Moon's gravitational pull**
- **Sun's gravitational pull**
- **Centrifugal force**
- **Relative position of the moon and the sun with respect to the earth**
- **Distribution of land and ocean**
- **Irregularities in configuration of oceans**

TIDAL RANGE



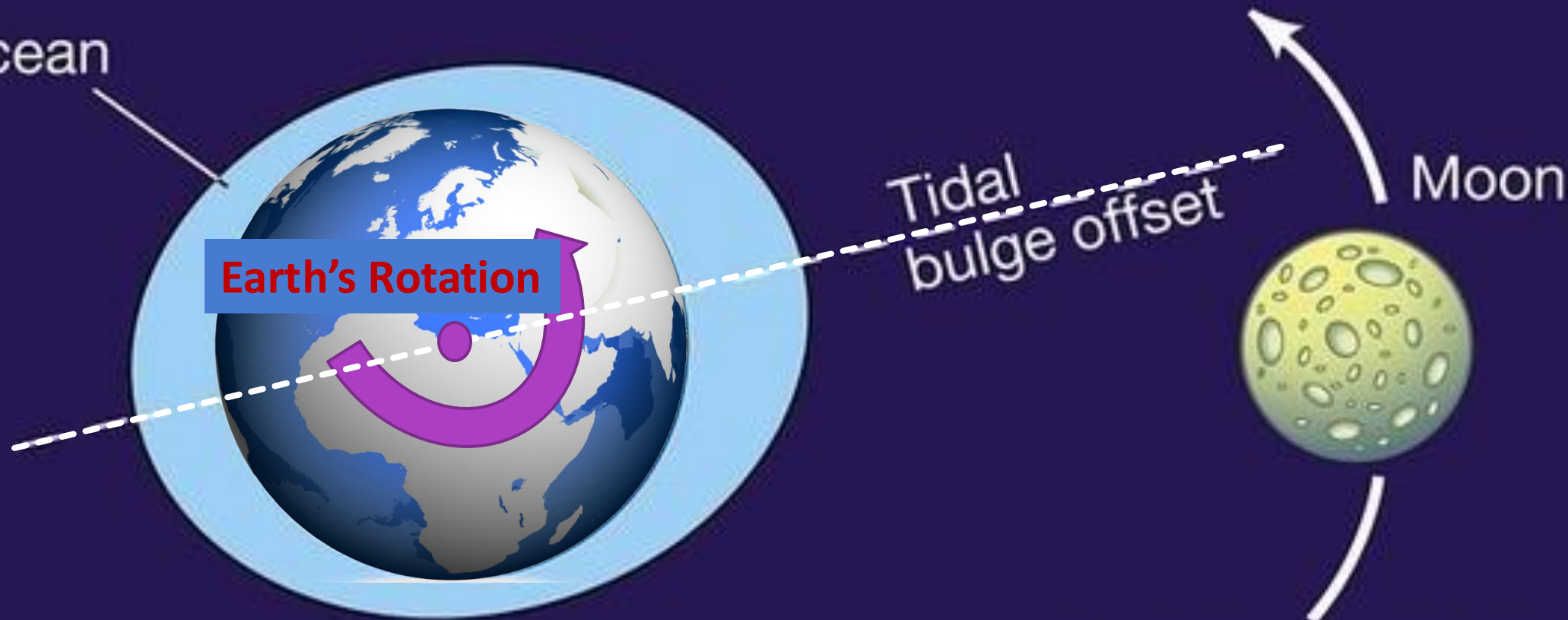
Ocean

Earth's Rotation

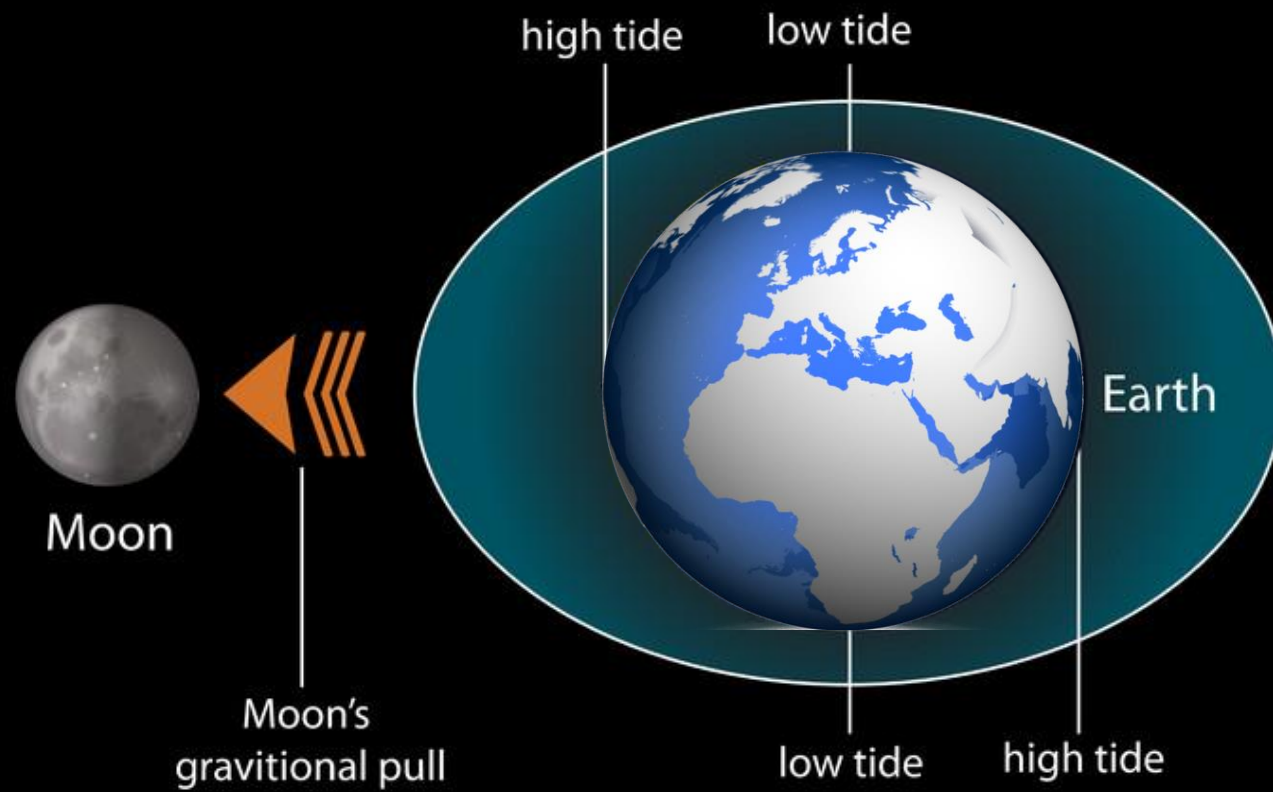
Tidal
bulge offset

Moon

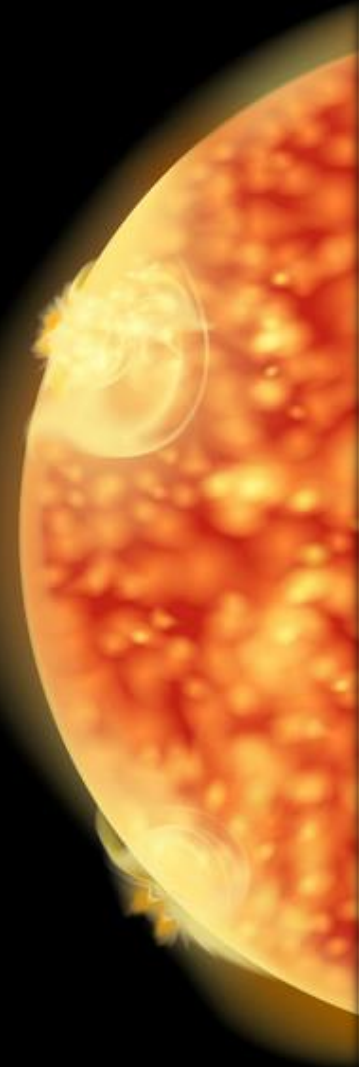
Direction of motion



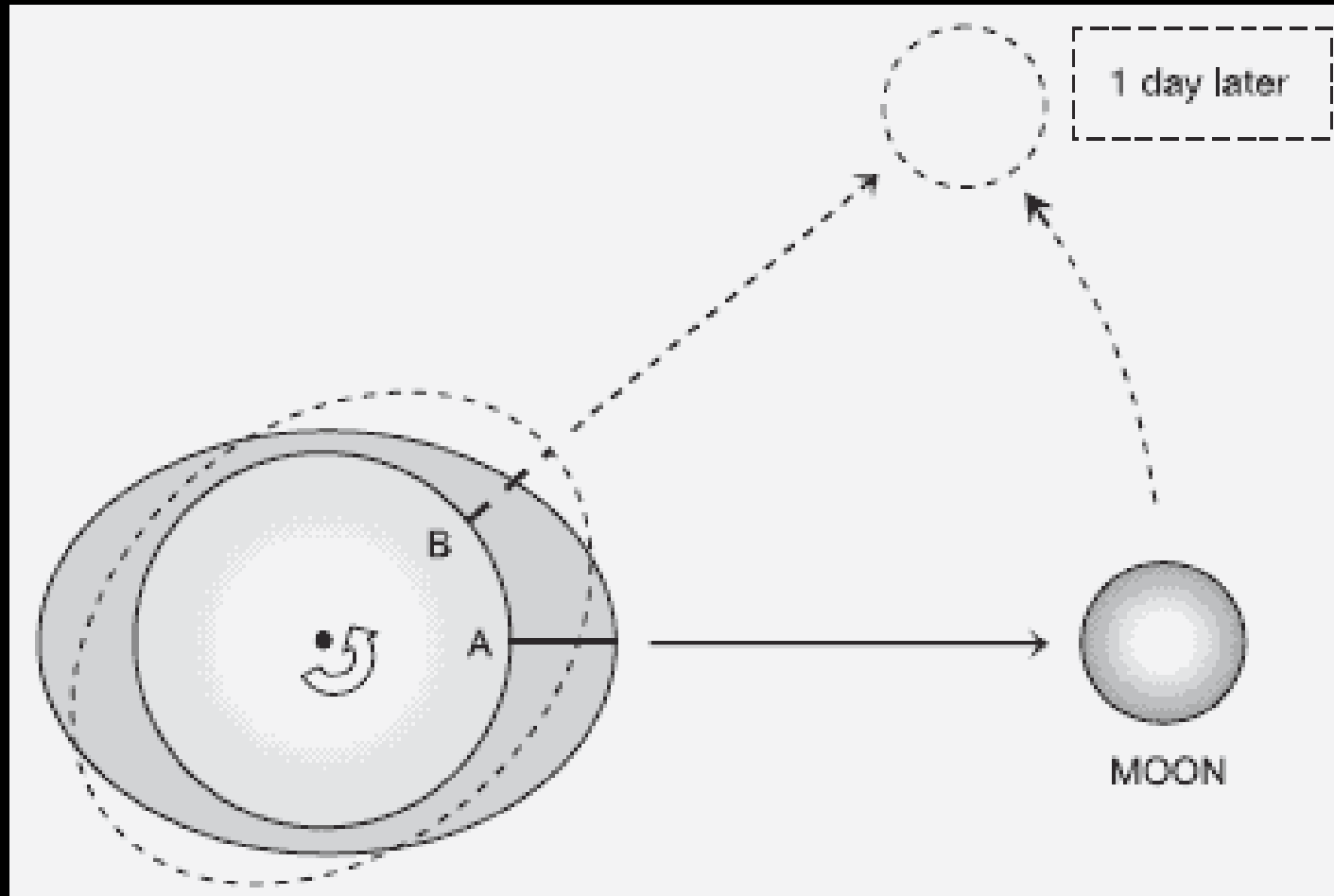
Ocean Tides



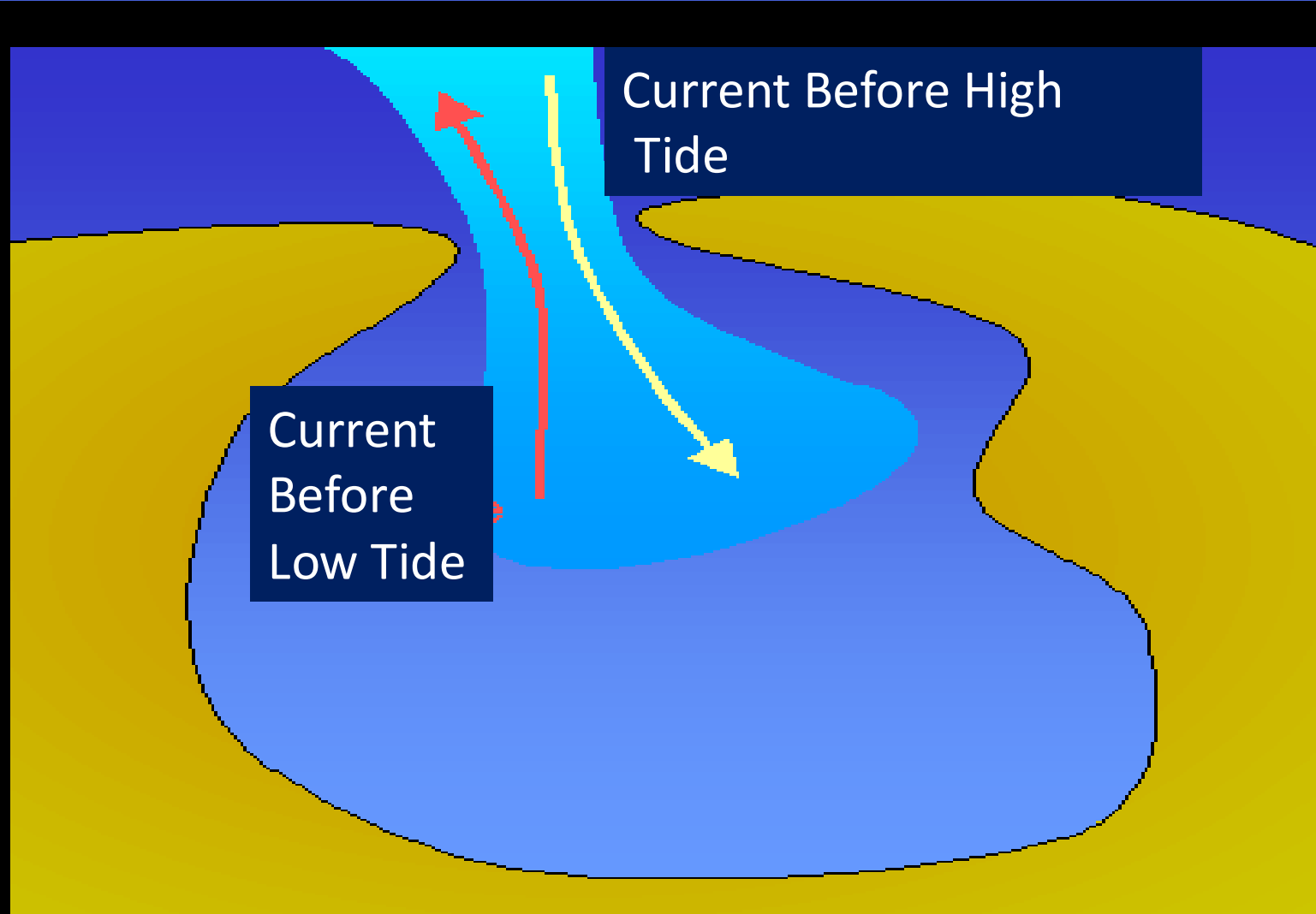
Sun



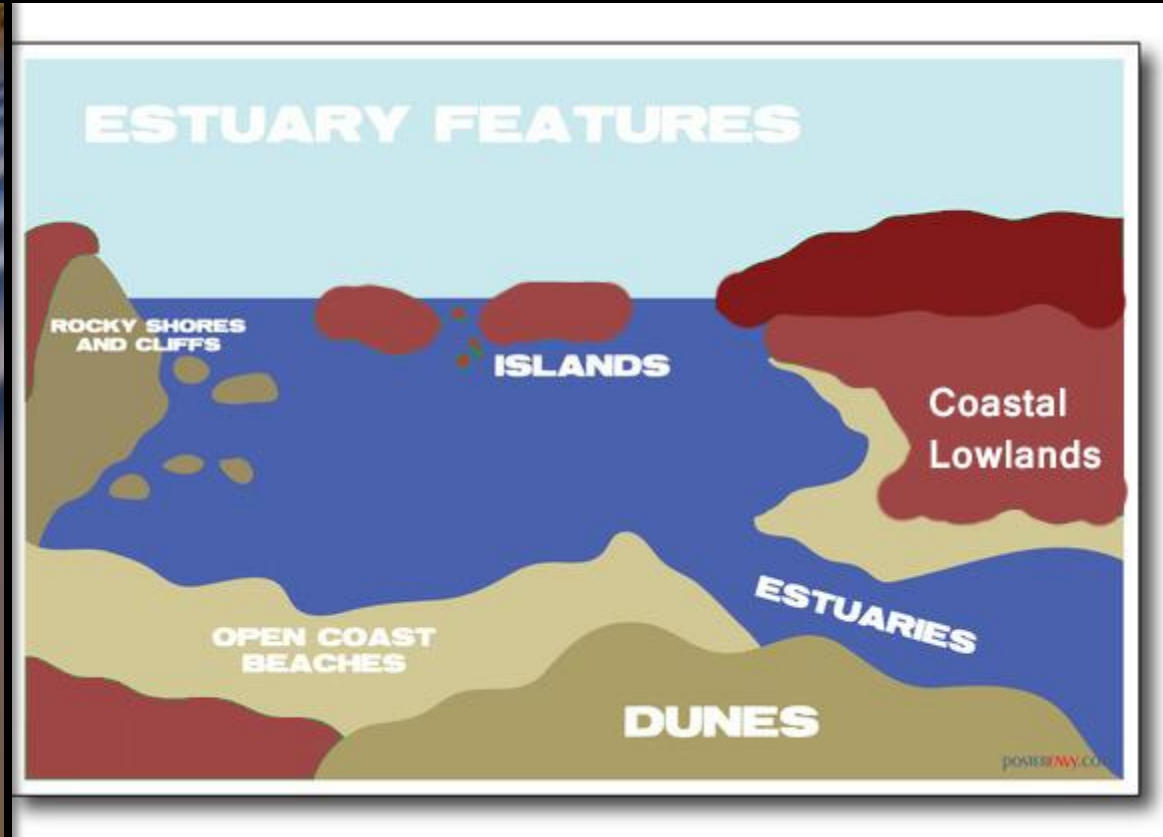
TIME OF TIDES



TIDAL CURRENT



TIDAL BORE



TIDAL PORT



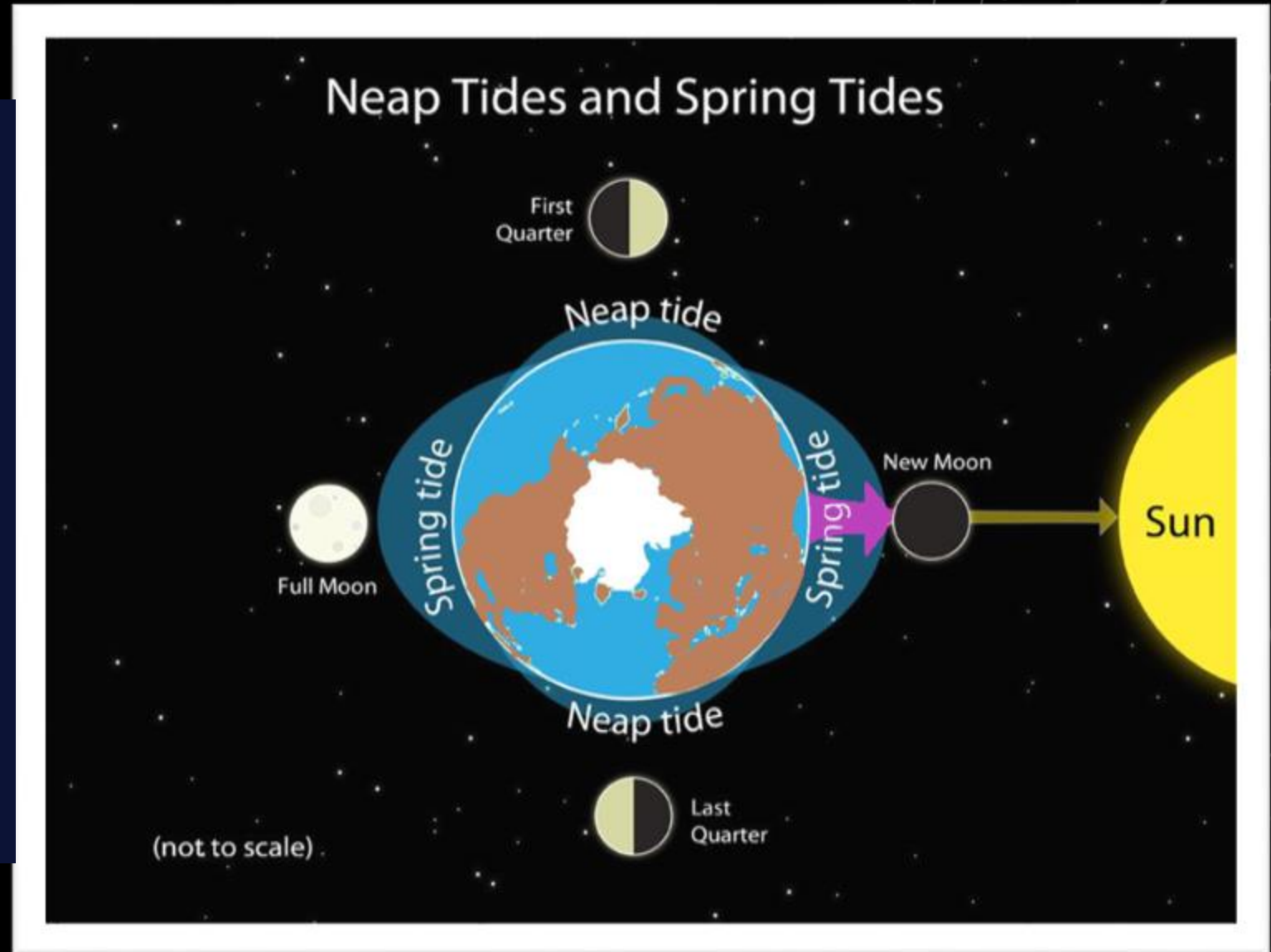
TYPES OF TIDE

☐ SPRING TIDE

- **Straight line**
- **Twice a Month - full moon; new moon**
- High tides are higher
- Low tides are lower

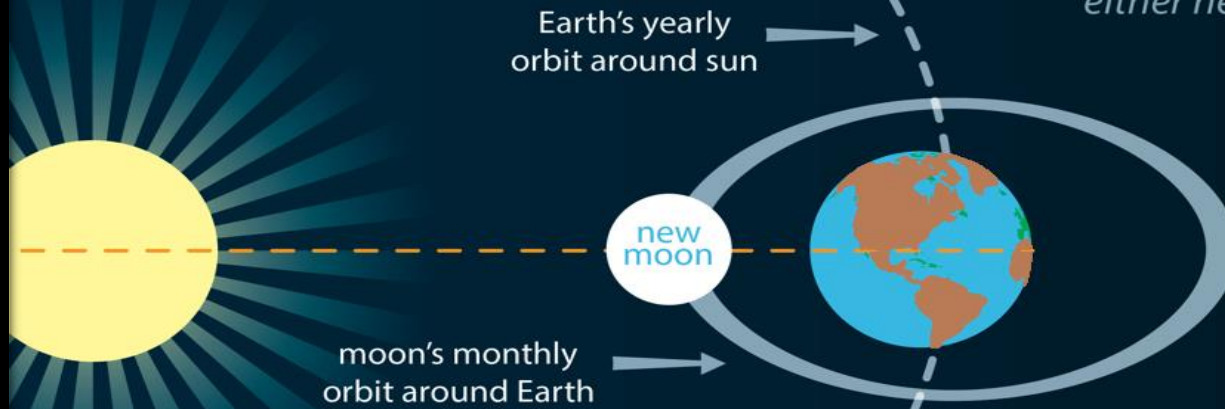
☐ NEAP TIDE

- Right angles
- First and third quarter
- High tides are lower than usual
- Low tides are higher than usual



PERIGEAN-SPRING TIDE

A perigean spring tide occurs when the moon is either new or full and closest to Earth.

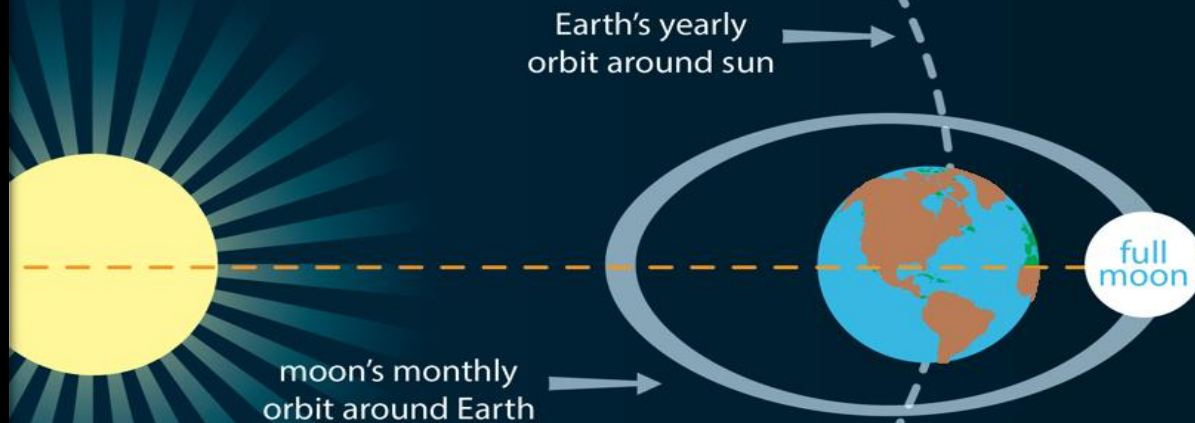


NEW MOON ○

Moon closest to Earth in monthly orbit (perigee)

Moon in alignment with sun

Moon between Earth and sun



FULL MOON ●

Moon closest to Earth in monthly orbit (perigee)

Moon in alignment with sun

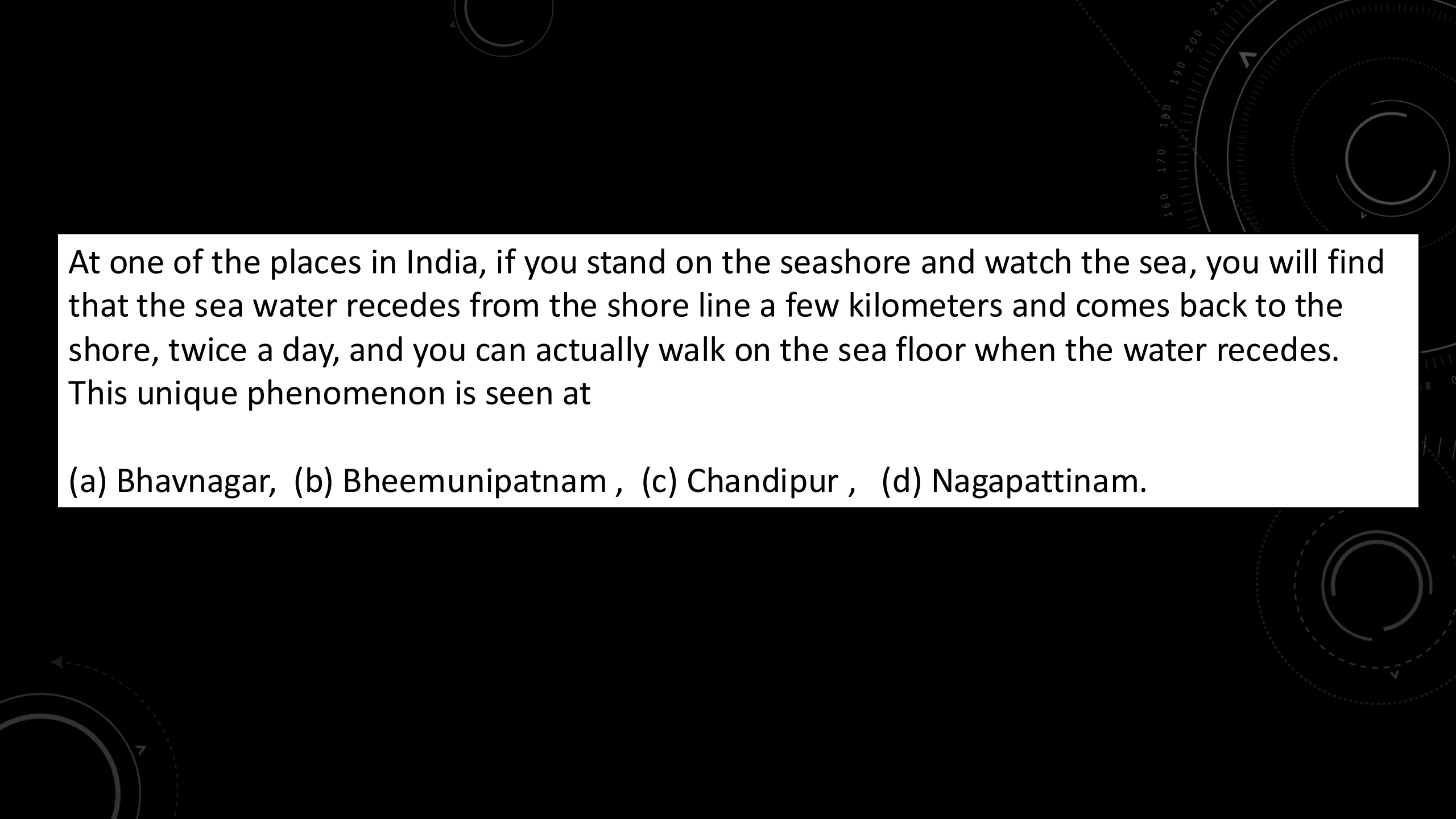
Earth between moon and sun

Not to scale.



IMPORTANCE OF TIDES

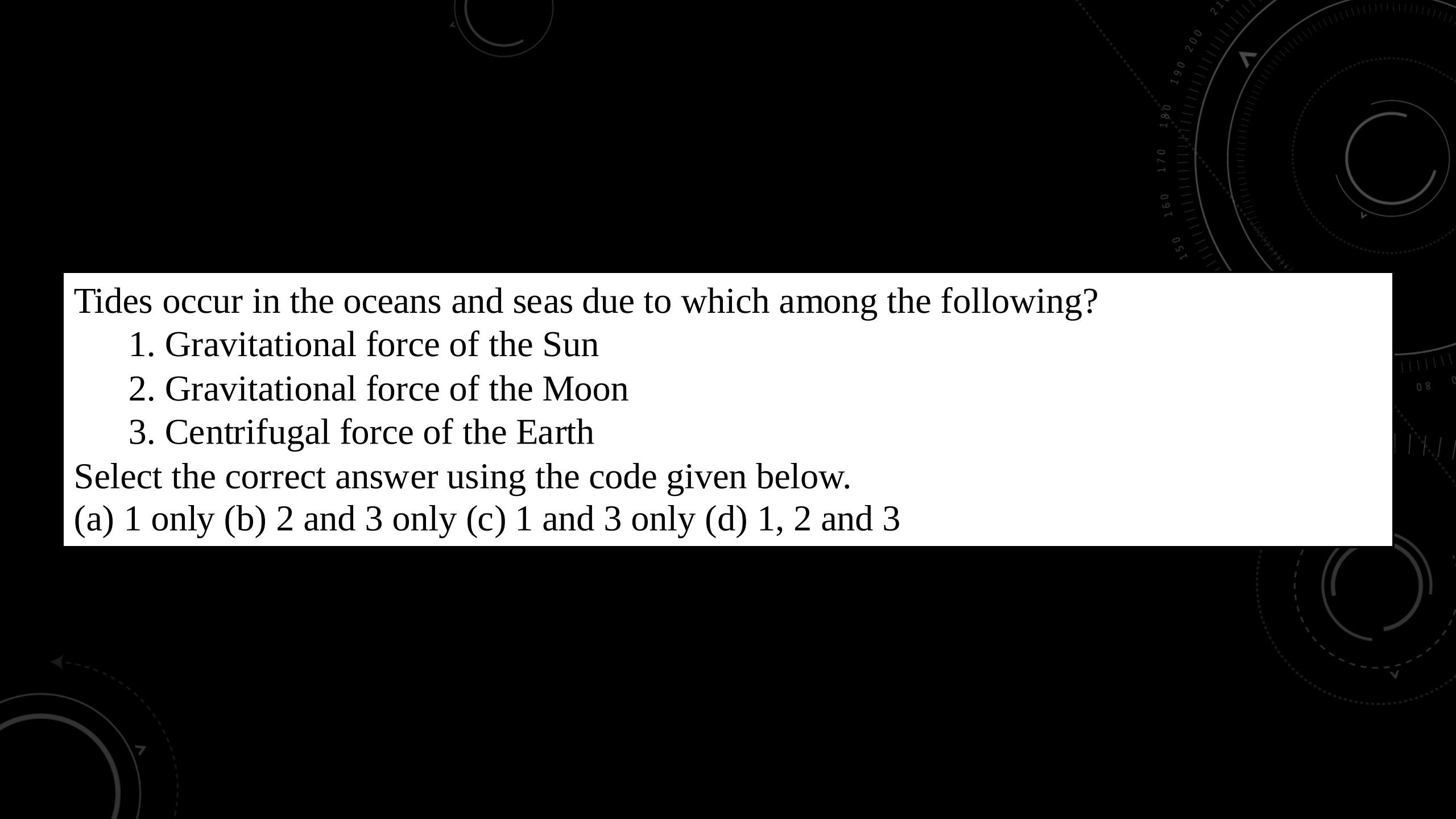
- Navigation
- Fishing
- Clear away the sediments
- Source for **generating electricity**

The background is dark with faint, light-colored circular patterns and a scale. The scale is located in the upper right quadrant, showing numbers from 160 to 210 in increments of 10. There are also circular arrows indicating a clockwise direction.

At one of the places in India, if you stand on the seashore and watch the sea, you will find that the sea water recedes from the shore line a few kilometers and comes back to the shore, twice a day, and you can actually walk on the sea floor when the water recedes. This unique phenomenon is seen at

(a) Bhavnagar, (b) Bheemunipatnam , (c) Chandipur , (d) Nagapattinam.



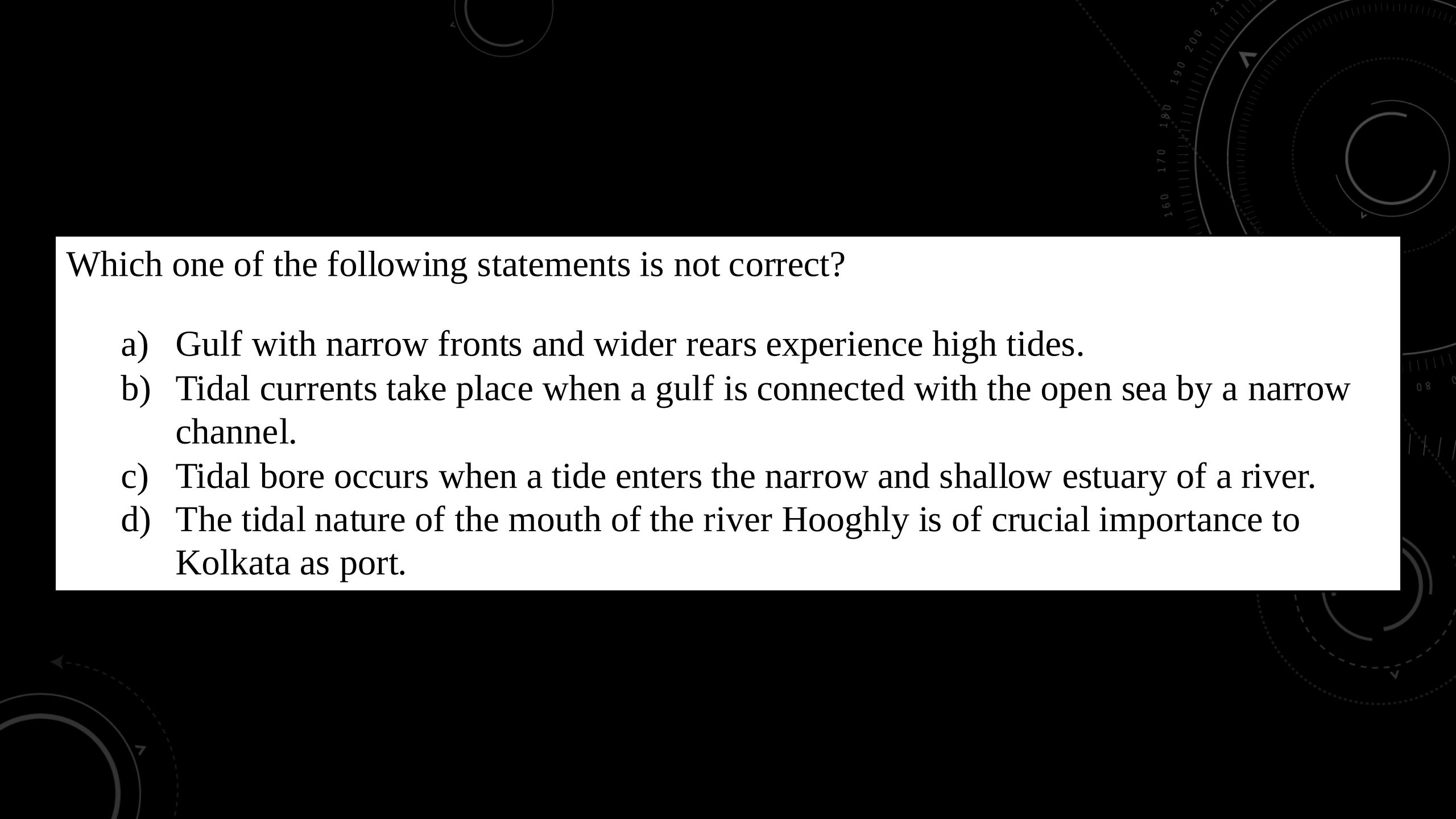
The background is dark with faint, light-colored circular patterns. On the right side, there is a scale with numbers 150, 160, 170, 180, 190, 200, and 210. There are also some curved arrows and concentric circles, suggesting a technical or scientific theme.

Tides occur in the oceans and seas due to which among the following?

1. Gravitational force of the Sun
2. Gravitational force of the Moon
3. Centrifugal force of the Earth

Select the correct answer using the code given below.

(a) 1 only (b) 2 and 3 only (c) 1 and 3 only (d) 1, 2 and 3

The background is dark with faint, light-colored circular patterns. On the right side, there is a scale with numbers 160, 170, 180, 190, 200, and 210. There are also some curved arrows and dashed lines, suggesting a technical or scientific theme.

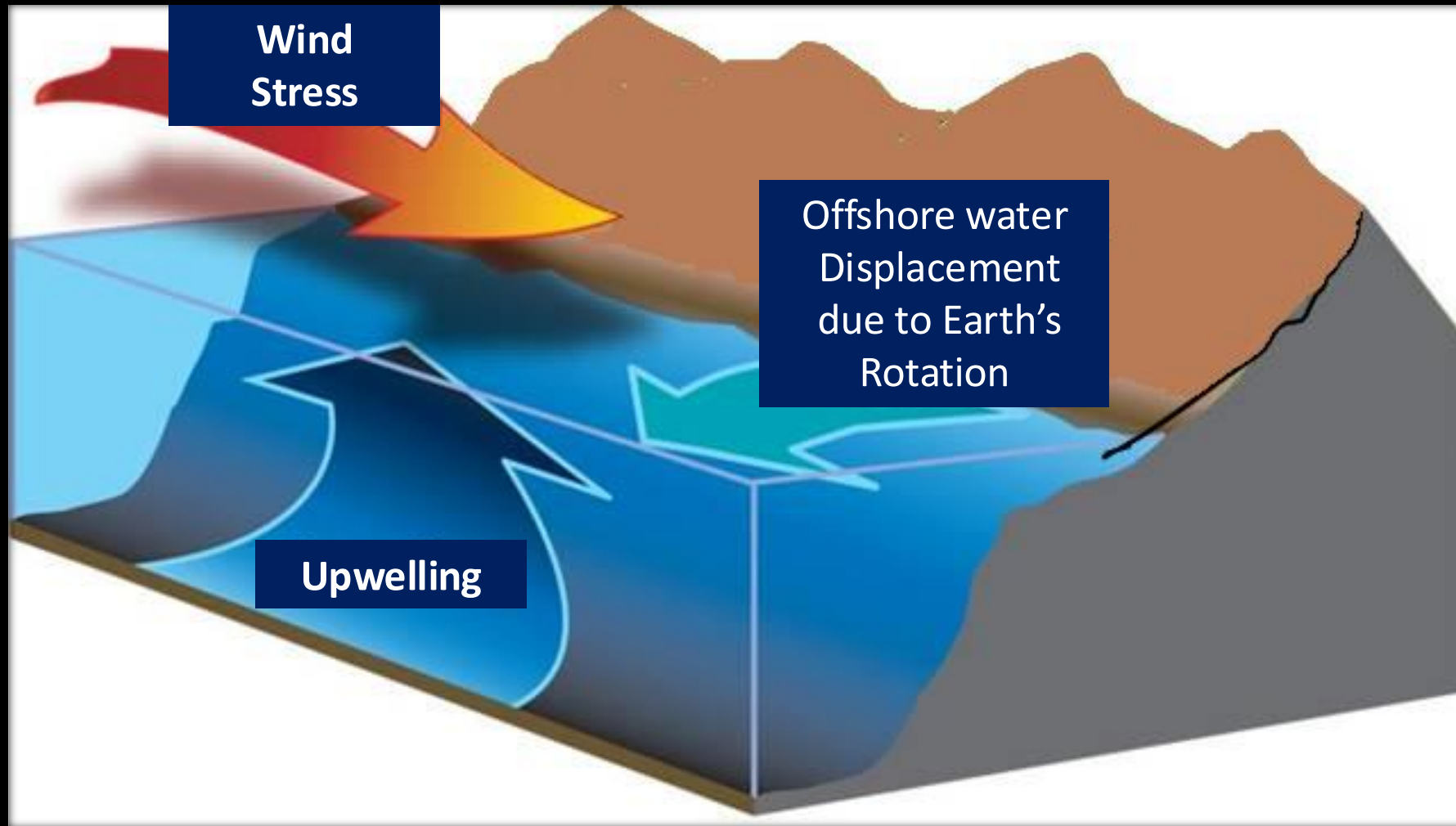
Which one of the following statements is not correct?

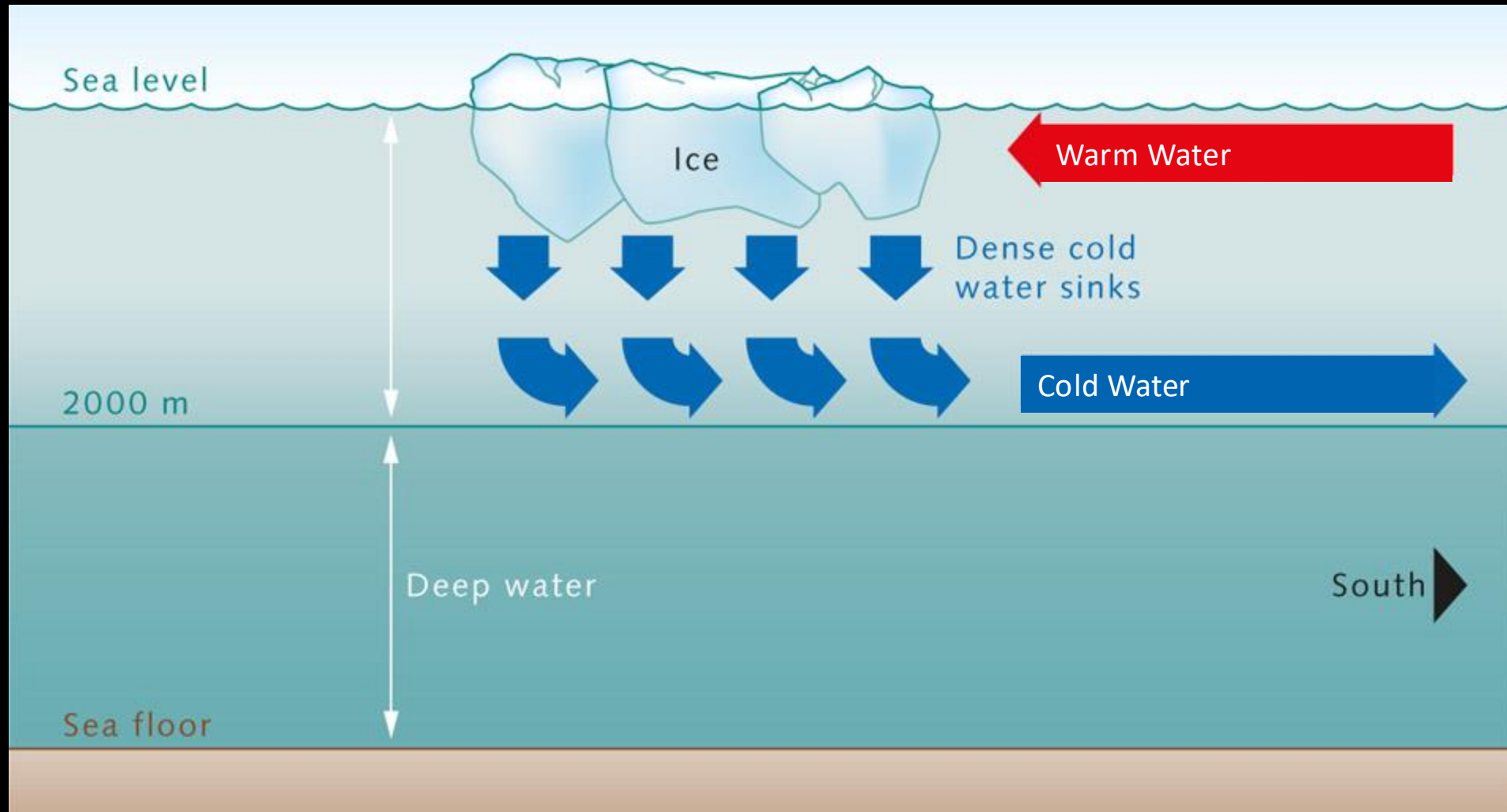
- a) Gulf with narrow fronts and wider rears experience high tides.
- b) Tidal currents take place when a gulf is connected with the open sea by a narrow channel.
- c) Tidal bore occurs when a tide enters the narrow and shallow estuary of a river.
- d) The tidal nature of the mouth of the river Hooghly is of crucial importance to Kolkata as port.

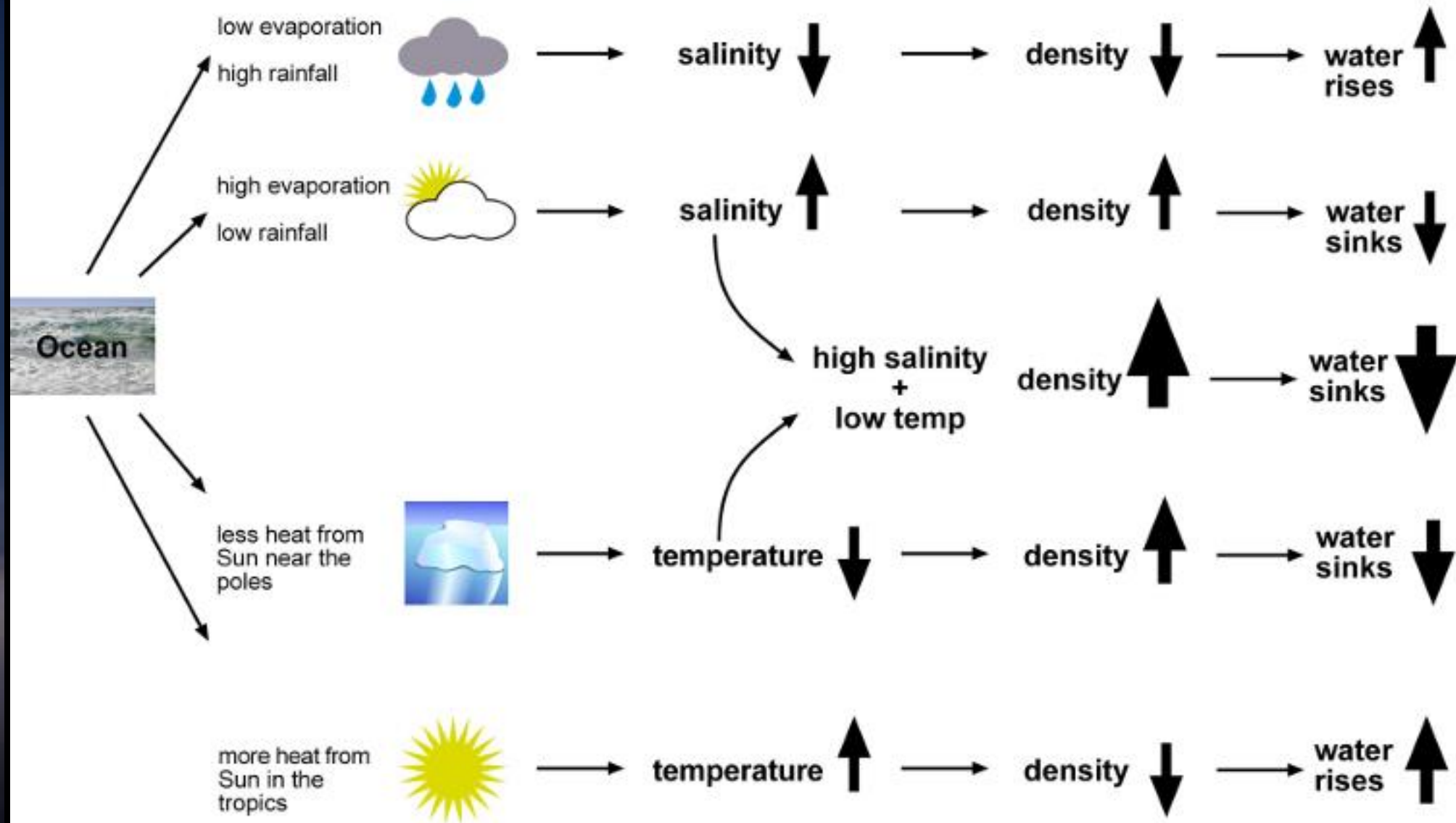
OCEAN CURRENTS

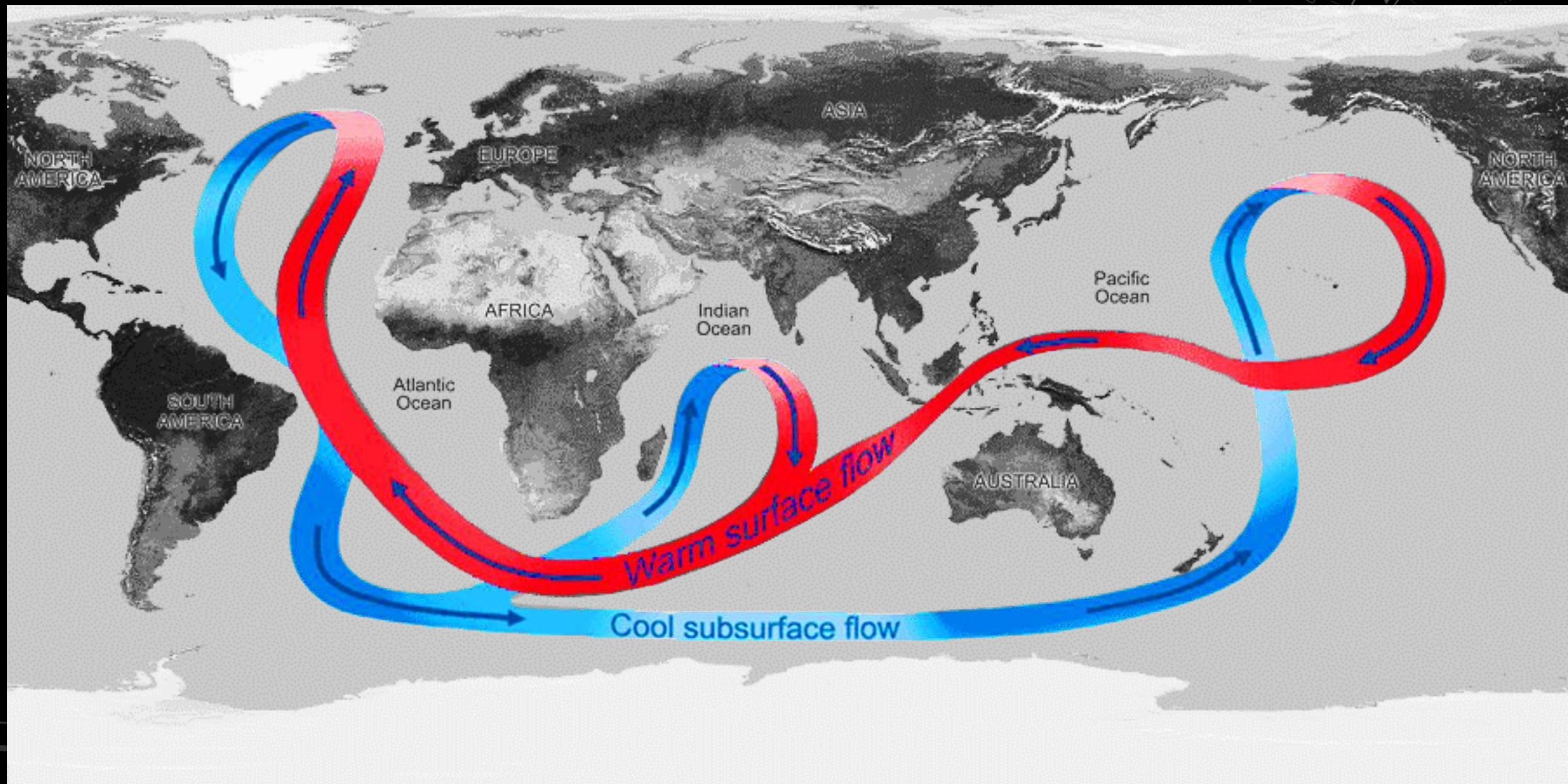
□ FACTORS

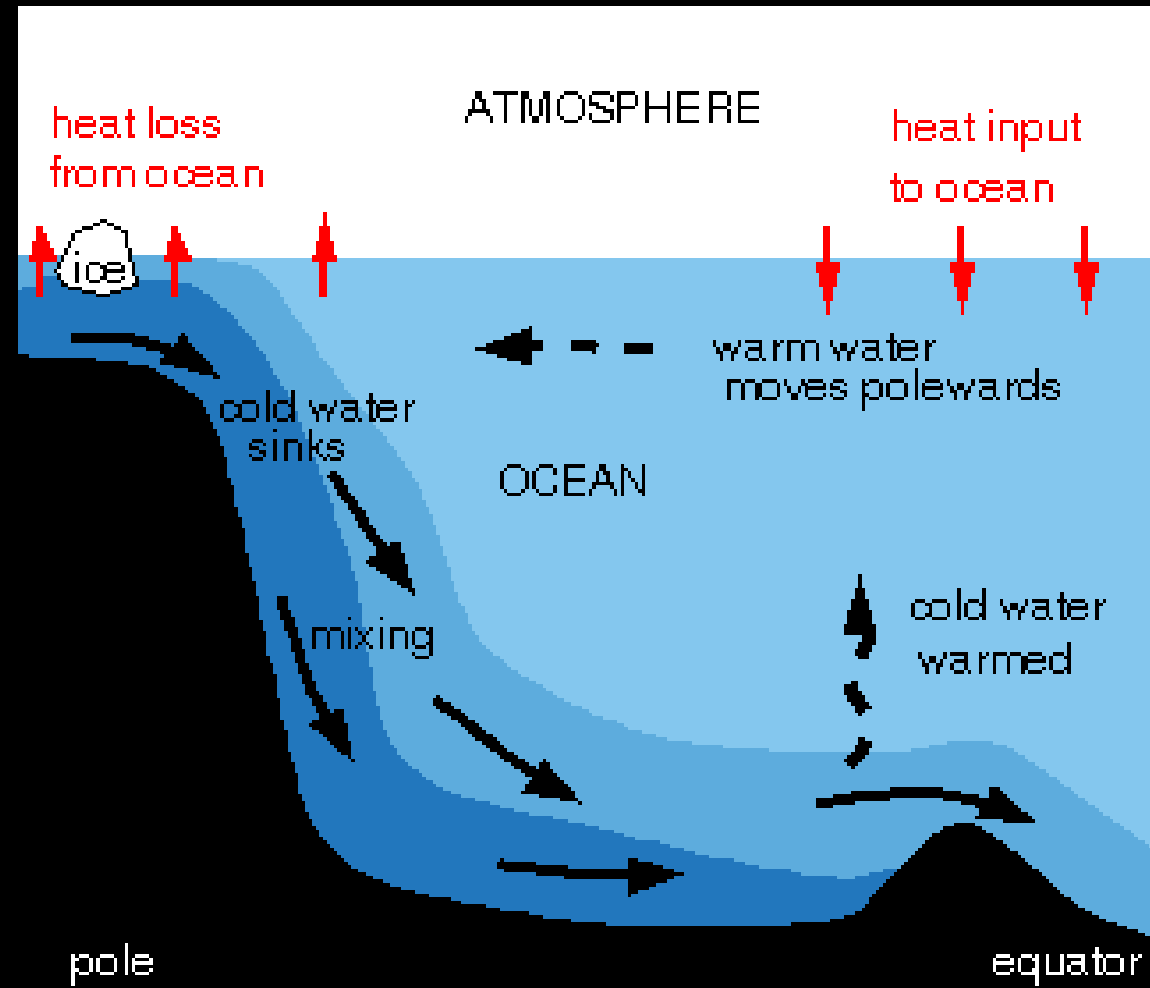
- Heating by solar energy
- Wind
- Gravity
- Coriolis force
- Differences in **water density**
- **Salinity**
- Ocean relief features

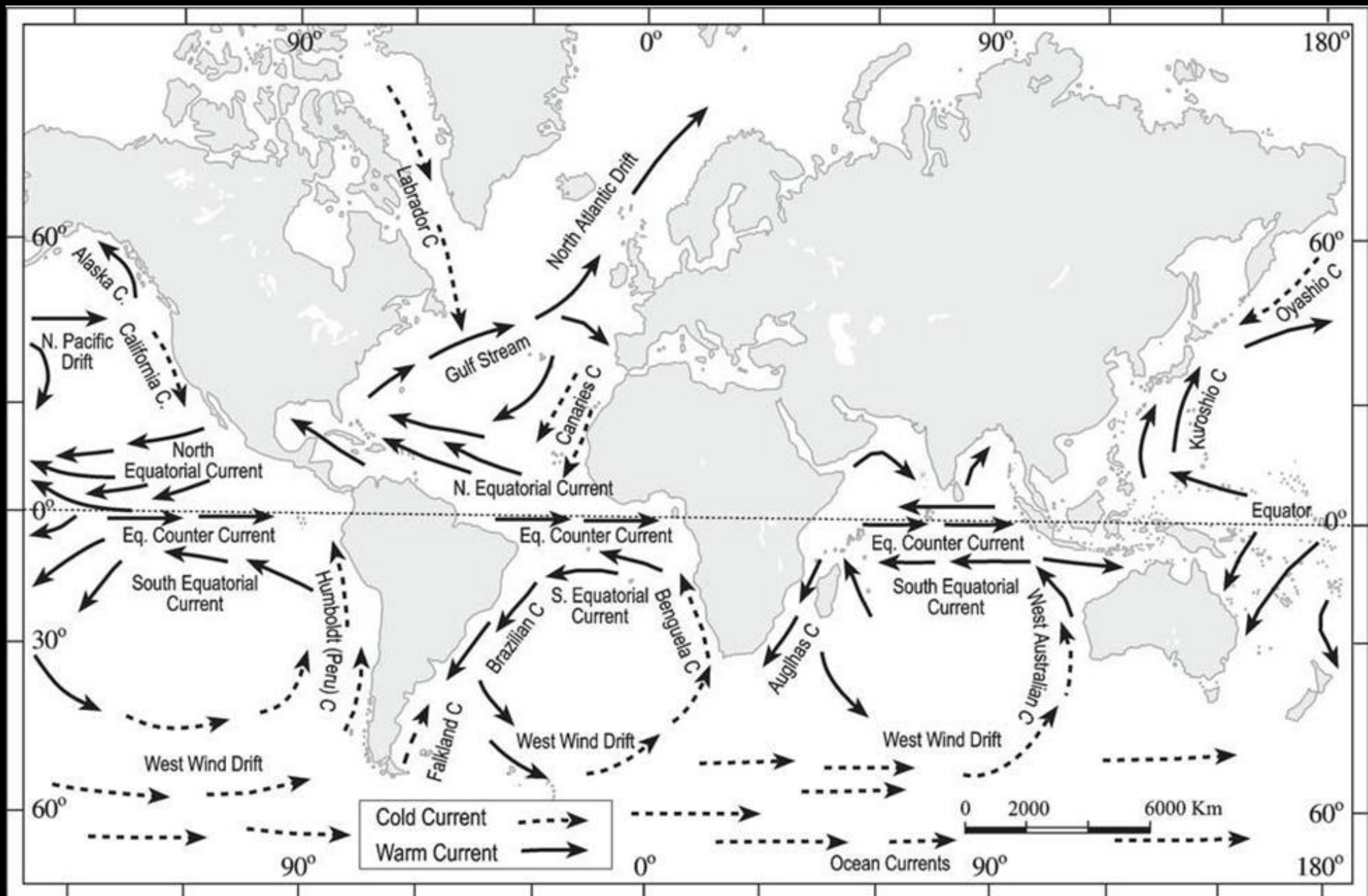


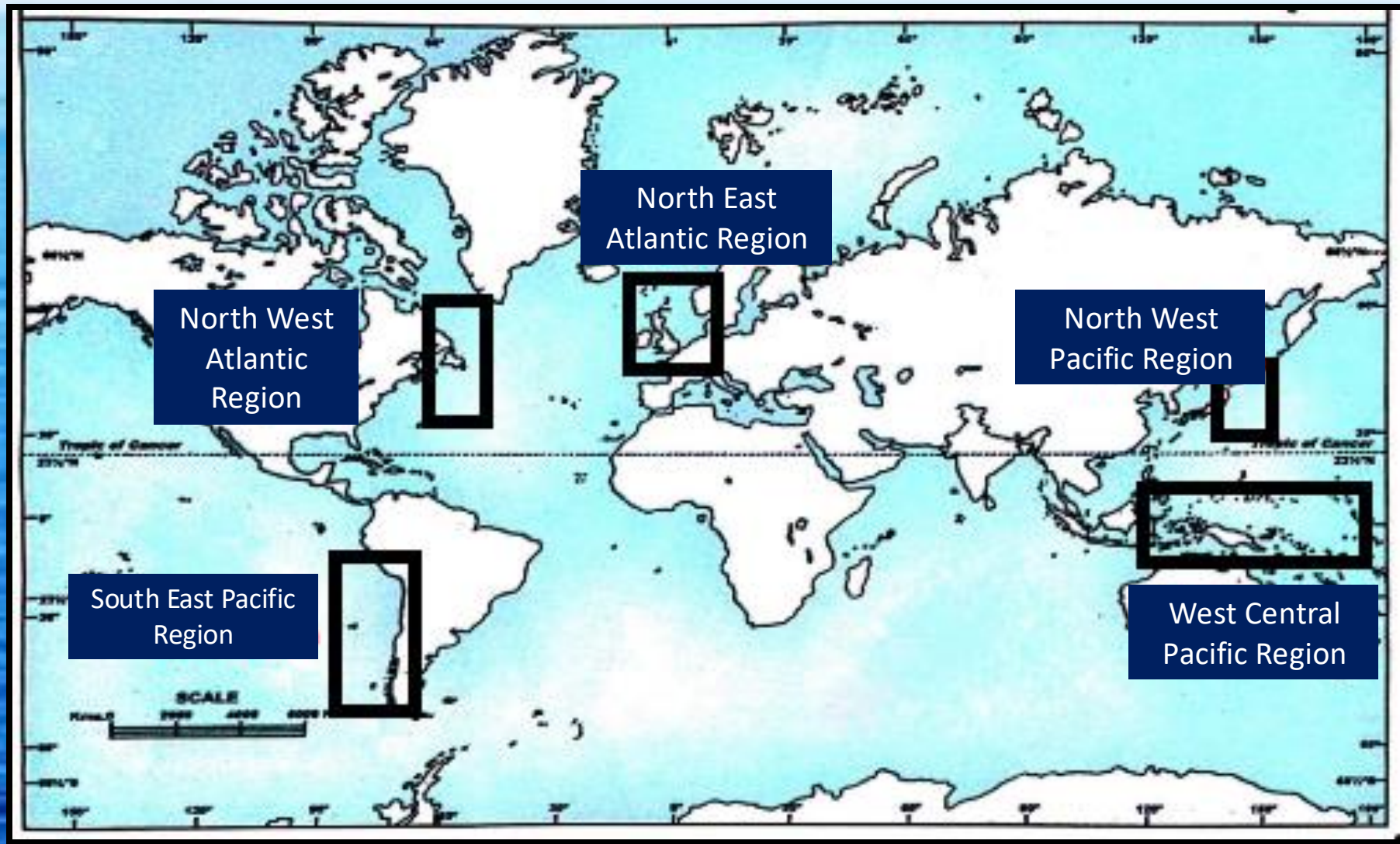






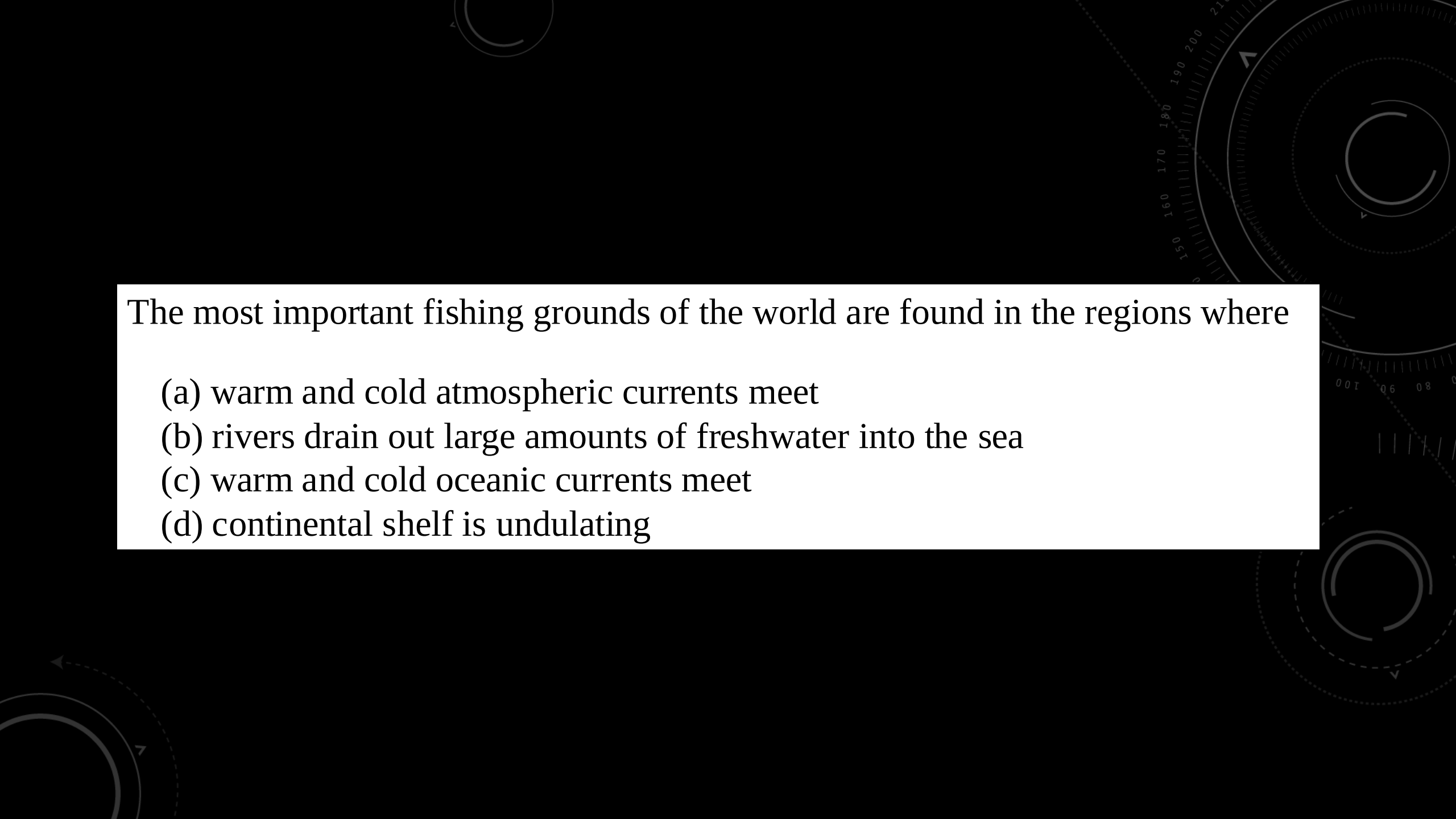






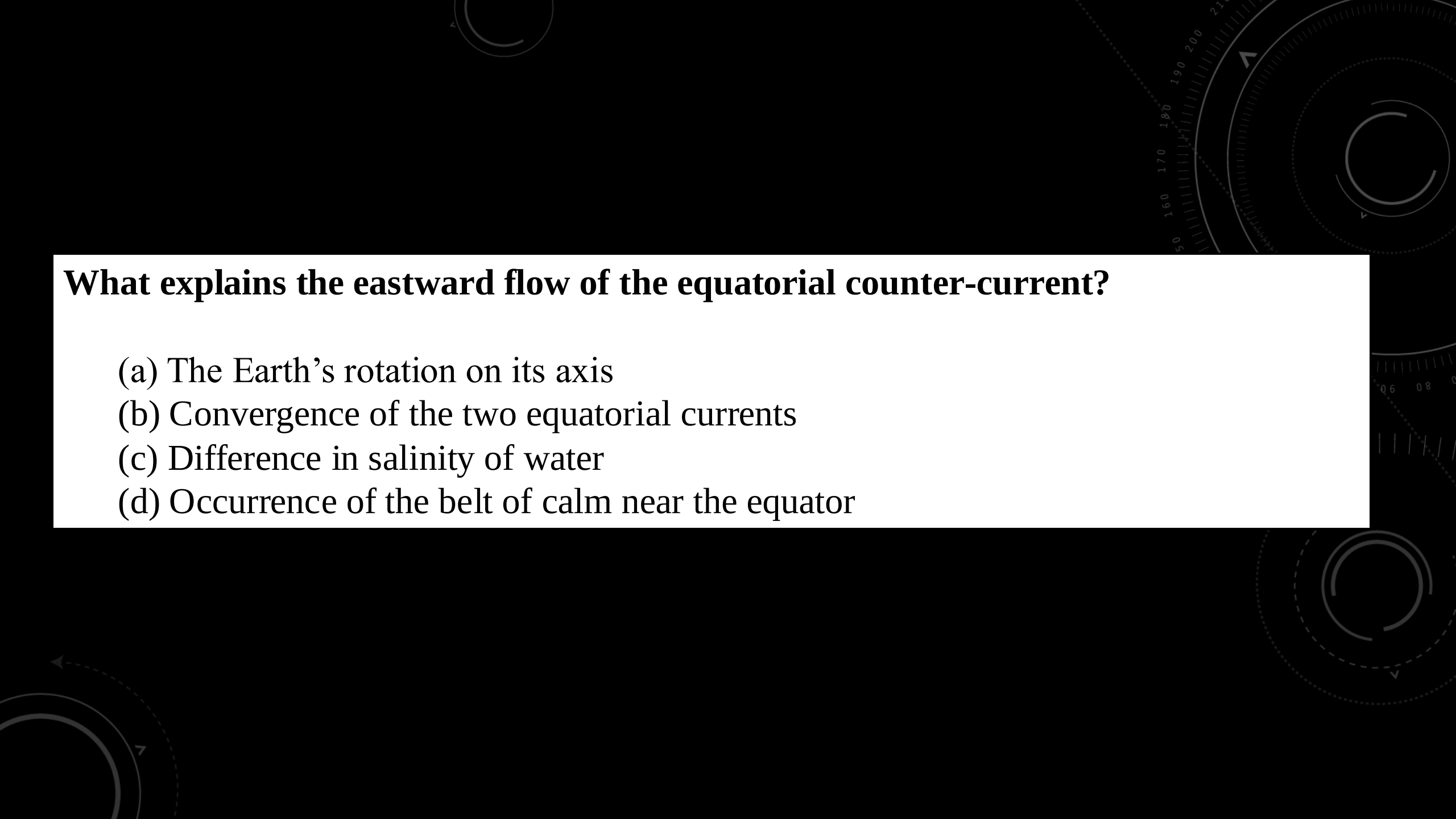
EFFECTS OF OCEAN CURRENTS

- Modification in the coastal climate
- Effects on fishing
- Effects on trade and navigation

The background is dark with faint, light-colored circular patterns and numbers. Some numbers like 150, 160, 170, 180, 190, 200, and 210 are visible along with curved arrows, suggesting a technical or scientific theme.

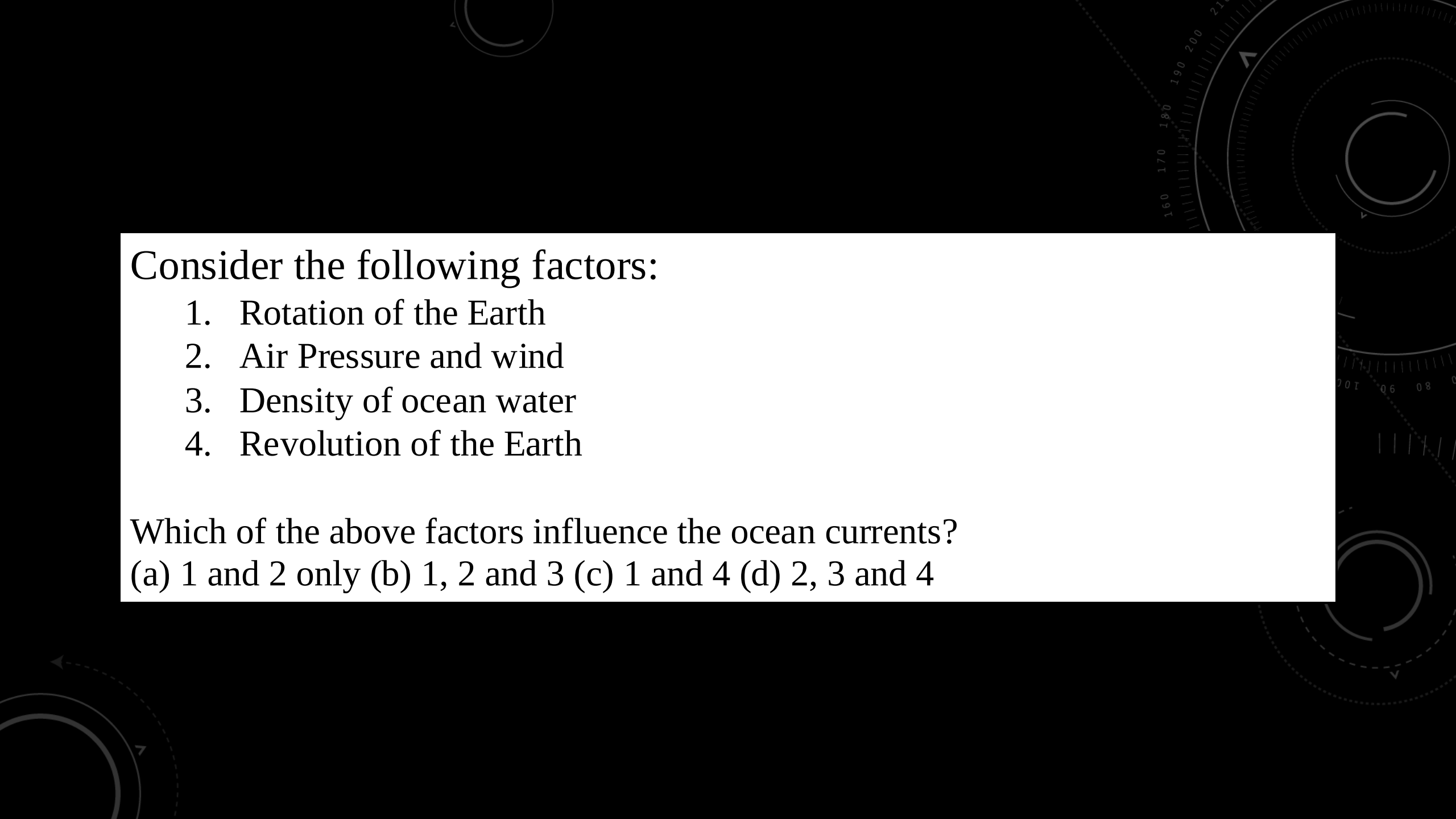
The most important fishing grounds of the world are found in the regions where

- (a) warm and cold atmospheric currents meet
- (b) rivers drain out large amounts of freshwater into the sea
- (c) warm and cold oceanic currents meet
- (d) continental shelf is undulating

The background is dark with several faint, light-gray circular patterns. One prominent pattern on the right side features concentric circles with radial tick marks, resembling a scale or a compass rose. Other similar but less detailed circular motifs are scattered in the upper and lower portions of the frame.

What explains the eastward flow of the equatorial counter-current?

- (a) The Earth's rotation on its axis
- (b) Convergence of the two equatorial currents
- (c) Difference in salinity of water
- (d) Occurrence of the belt of calm near the equator



Consider the following factors:

1. Rotation of the Earth
2. Air Pressure and wind
3. Density of ocean water
4. Revolution of the Earth

Which of the above factors influence the ocean currents?

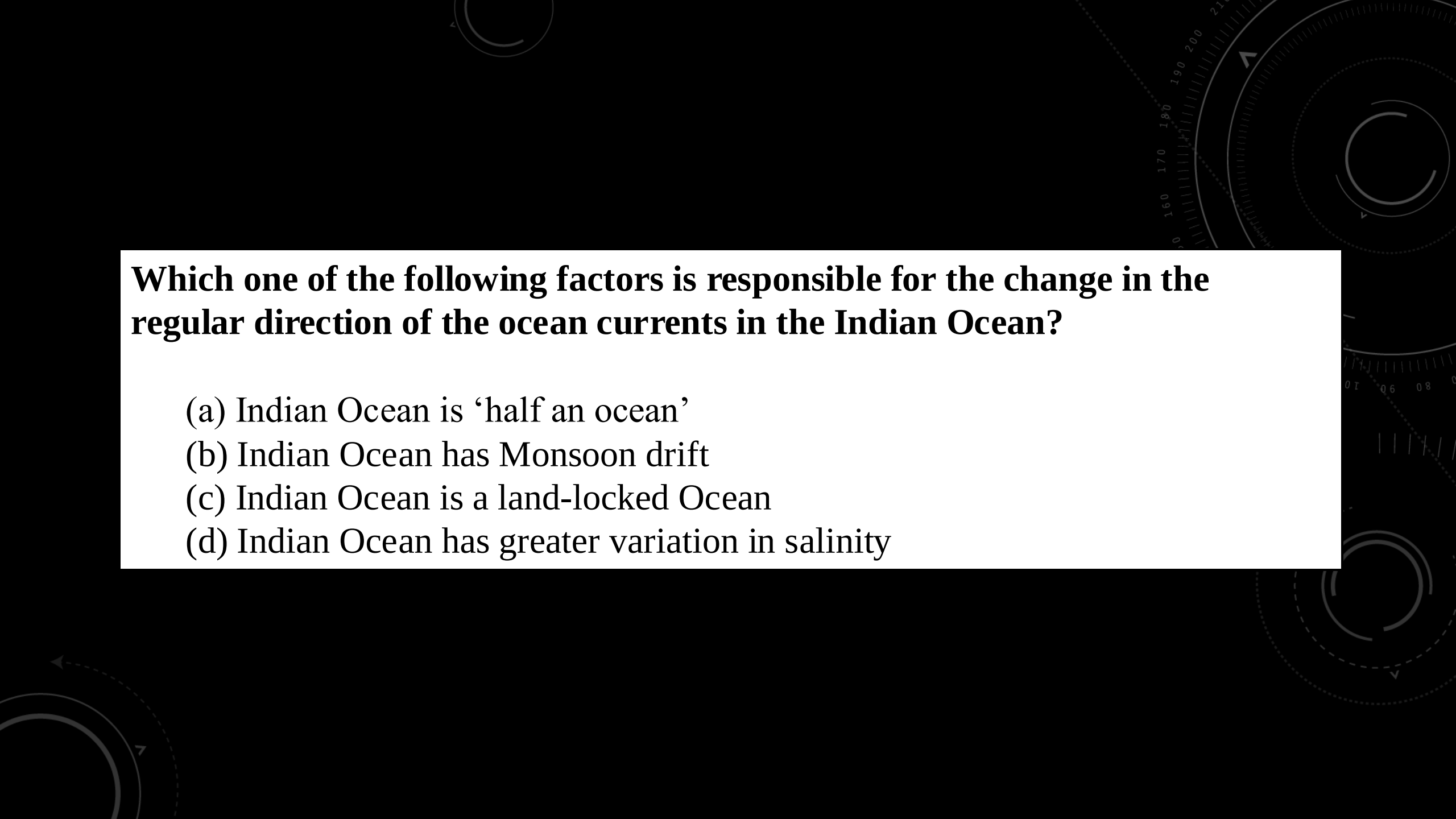
(a) 1 and 2 only (b) 1, 2 and 3 (c) 1 and 4 (d) 2, 3 and 4

Consider the following statements:

1. Ocean currents are the slow-surface movement of water in the ocean
2. Ocean currents assist in maintaining the Earth's heat balance
3. Ocean currents are set in motion primarily by prevailing winds
4. Ocean currents are affected by the configuration of the ocean

Which of these statements are correct?

(a) 1 and 2 (b) 2, 3 and 4 (c) 1, 3 and 4 (d) 1, 2, 3 and 4

The background of the slide features a dark, textured surface with faint, light-colored circular patterns. On the right side, there is a prominent circular scale with numerical markings ranging from 160 to 210, and an arrow pointing upwards. Other smaller circular elements are scattered across the background, some with arrows indicating direction.

Which one of the following factors is responsible for the change in the regular direction of the ocean currents in the Indian Ocean?

- (a) Indian Ocean is ‘half an ocean’
- (b) Indian Ocean has Monsoon drift
- (c) Indian Ocean is a land-locked Ocean
- (d) Indian Ocean has greater variation in salinity



PREVIOUS YEAR QUESTION (MAINS)

1. Explain the factors responsible for the origin of ocean currents. How do they influence regional climates, fishing and navigation? **(2015)**
- 

INDIAN MONSOON



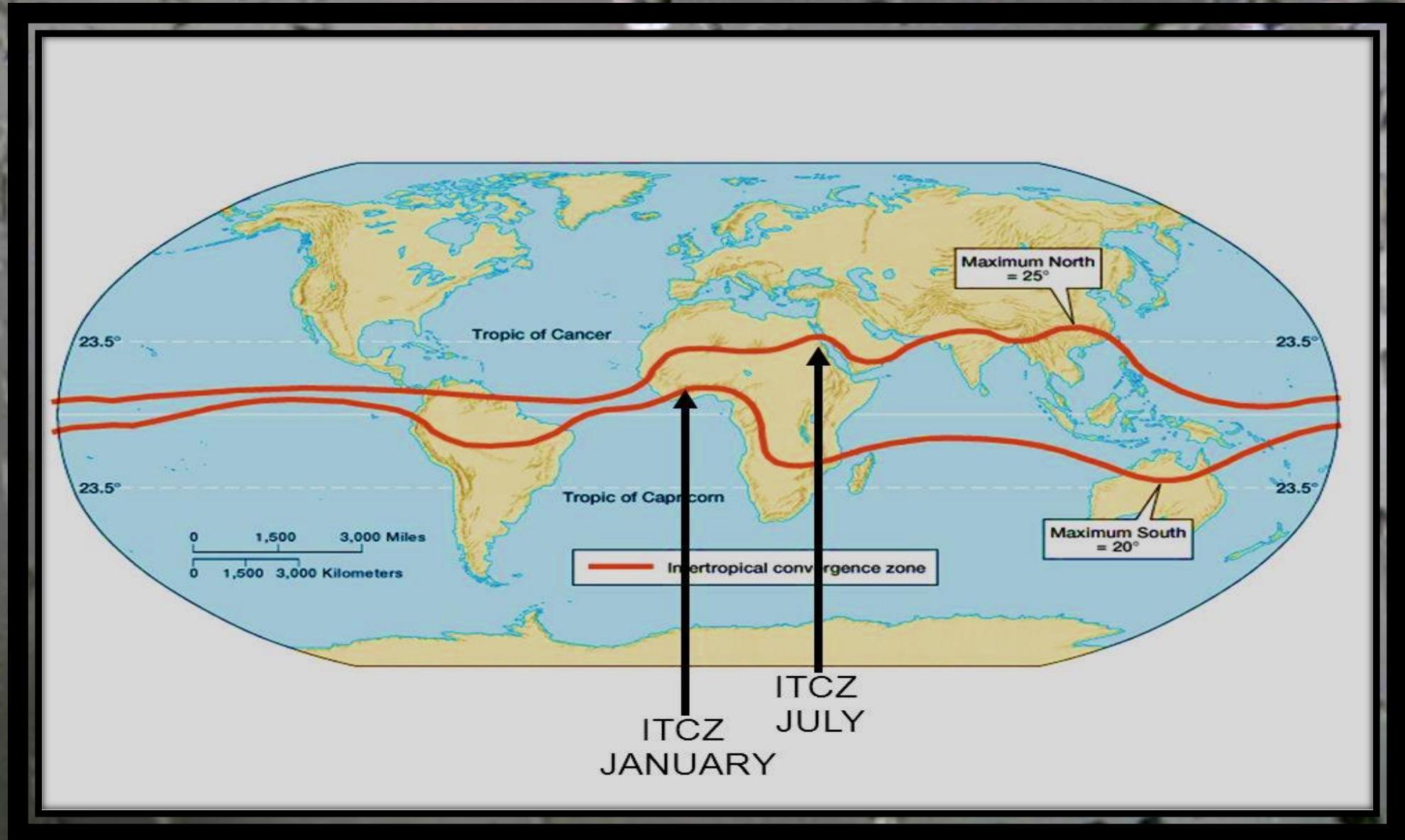
ORIGIN OF MONSOON

➤ ITCZ

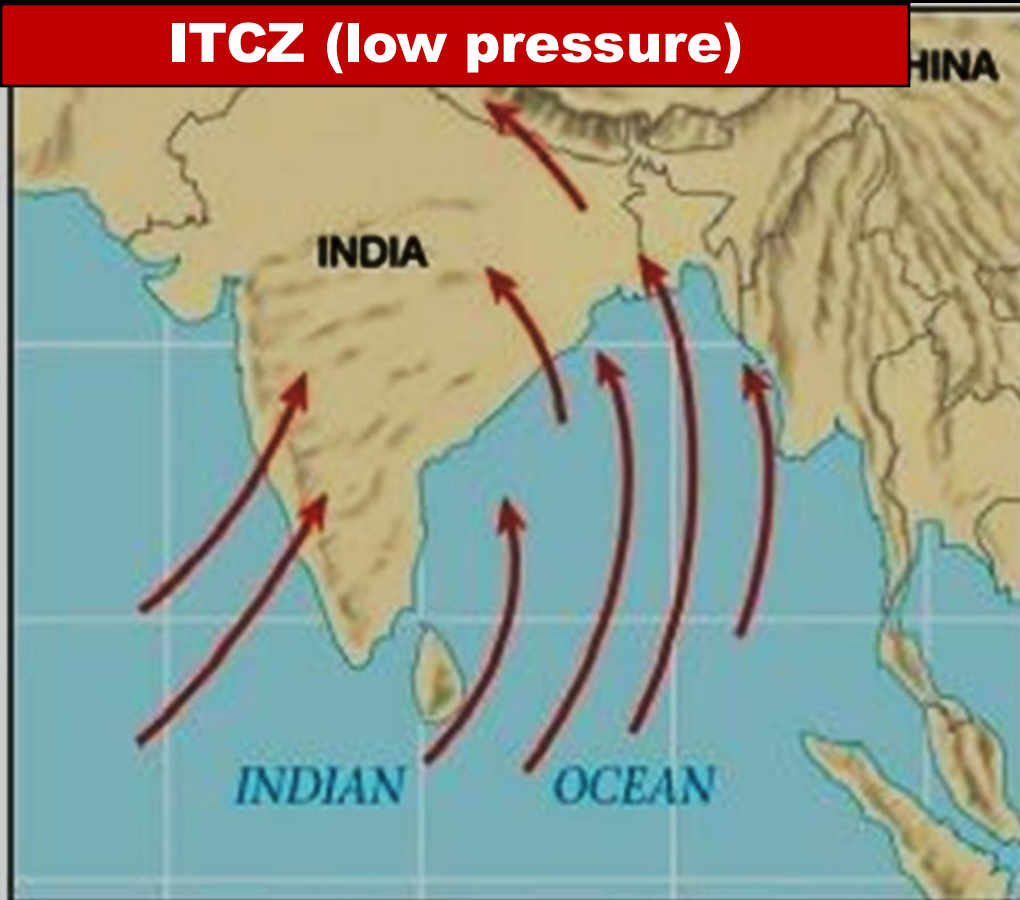
➤ THERMAL DIFFERENCE
BETWEEN LAND AND OCEAN

➤ MADAGASCAR HIGH

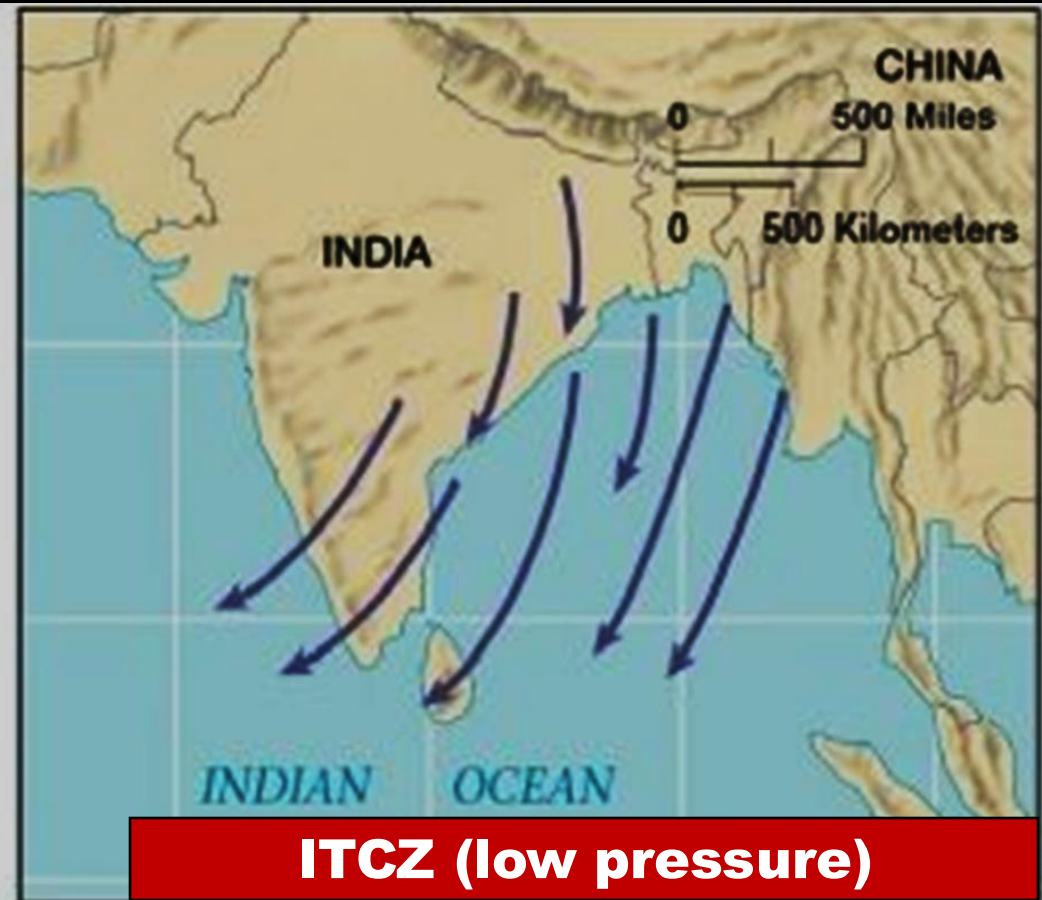
Inter Tropical Convergence Zone (ITCZ)



ITCZ (low pressure)

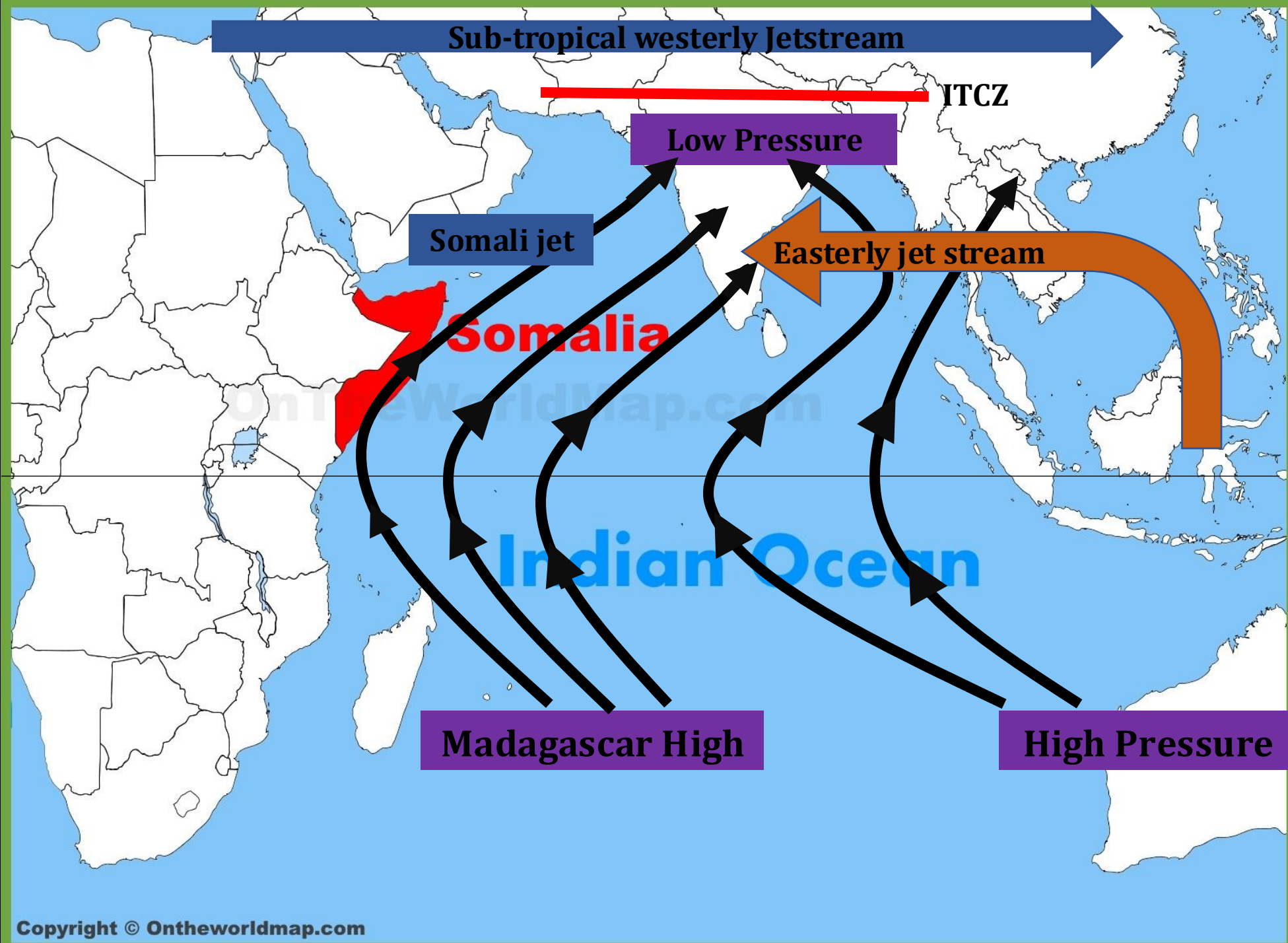


Summer

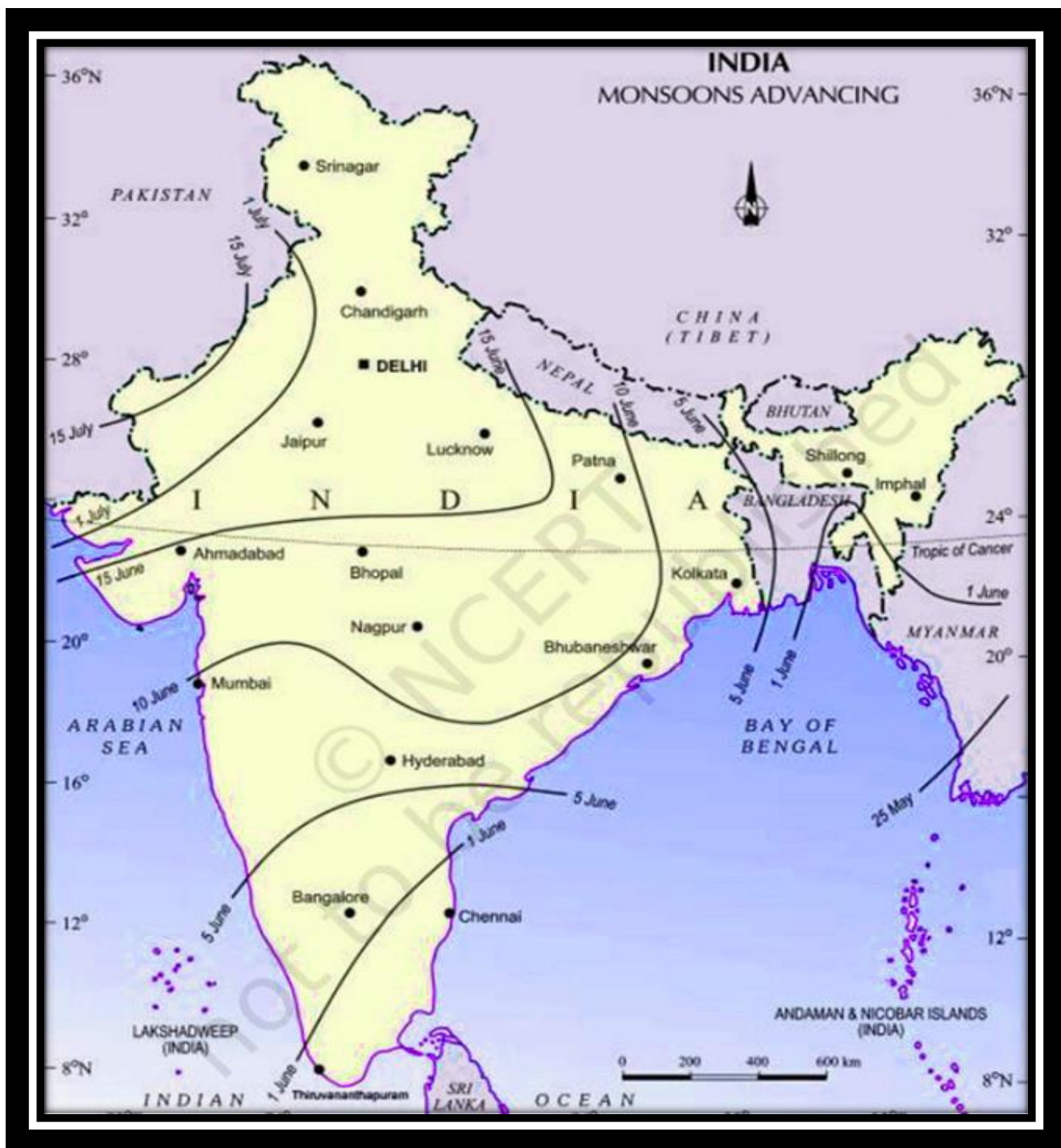


ITCZ (low pressure)

Winter



ADVANCING MONSOON



RETREATING MONSOON



IMPORTANT TERMS RELATED WITH MONSOON

✓ **The onset of the monsoon**

✓ **Rain-bearing systems**

✓ **Break in the monsoon**

✓ **Burst of monsoon**

✓ **Monsoon trough**

✓ **Normal monsoon**

FACTORS AFFECTING MONSOON

➤ **SEASONS**

➤ **CORIOLIS FORCE**

➤ **ENSO**

➤ **TROPICAL DEPRESSIONS**

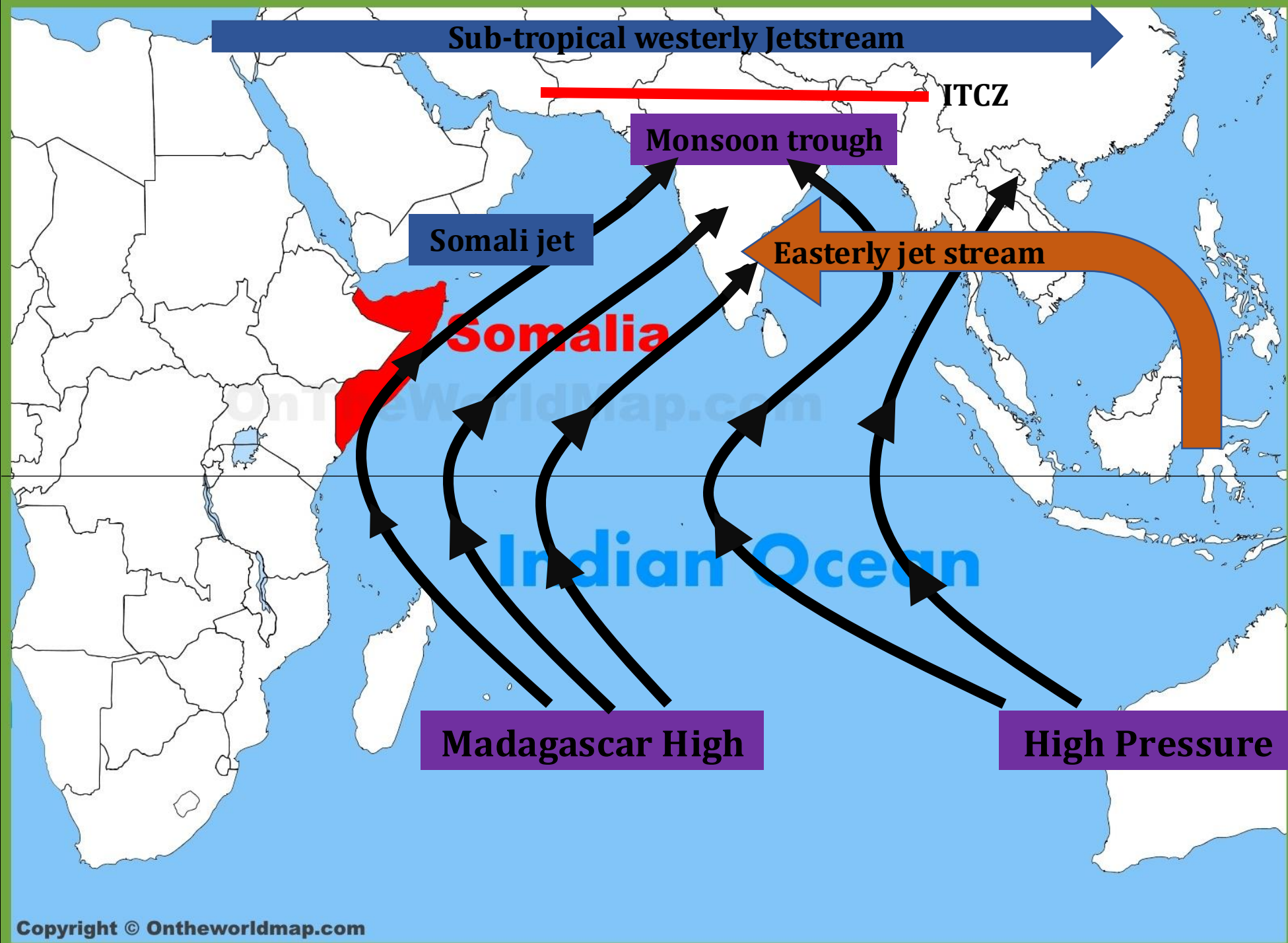
➤ **INDIAN OCEAN DIPOLE**

➤ **UPPER AIR CIRCULATION**

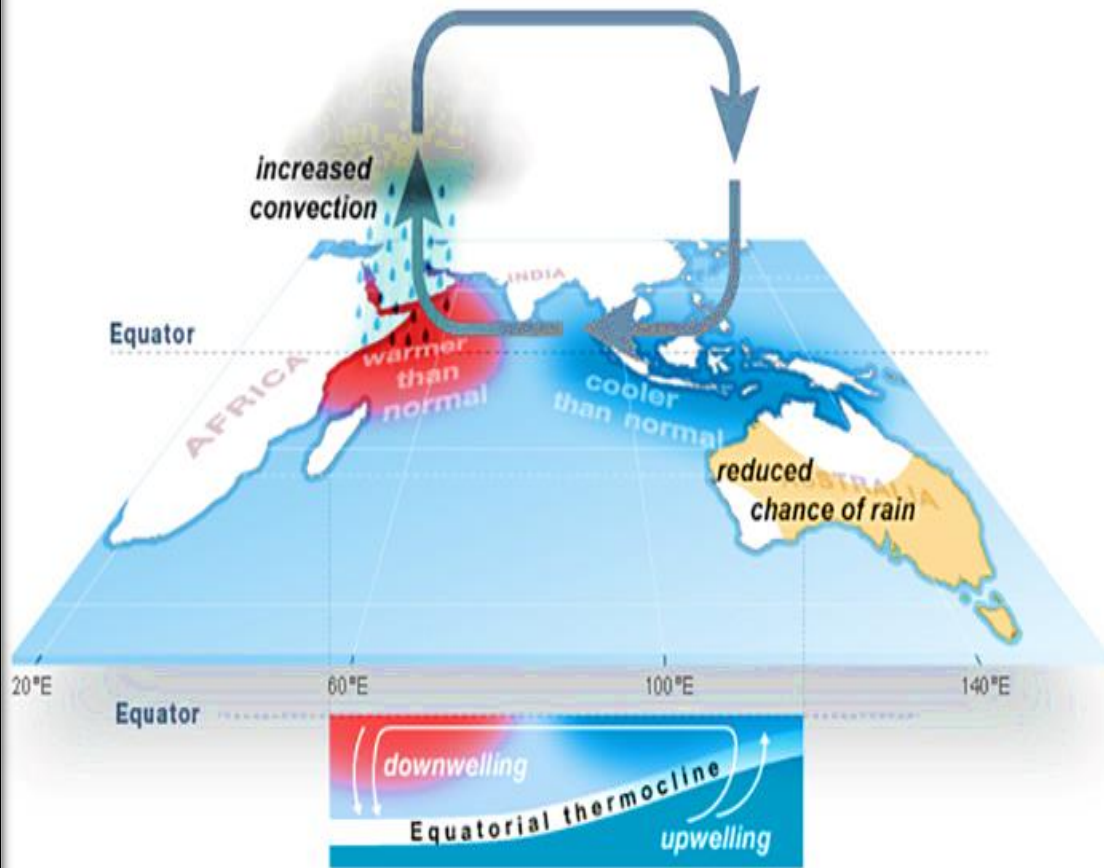
➤ **LANDSCAPE**

➤ **ITCZ**

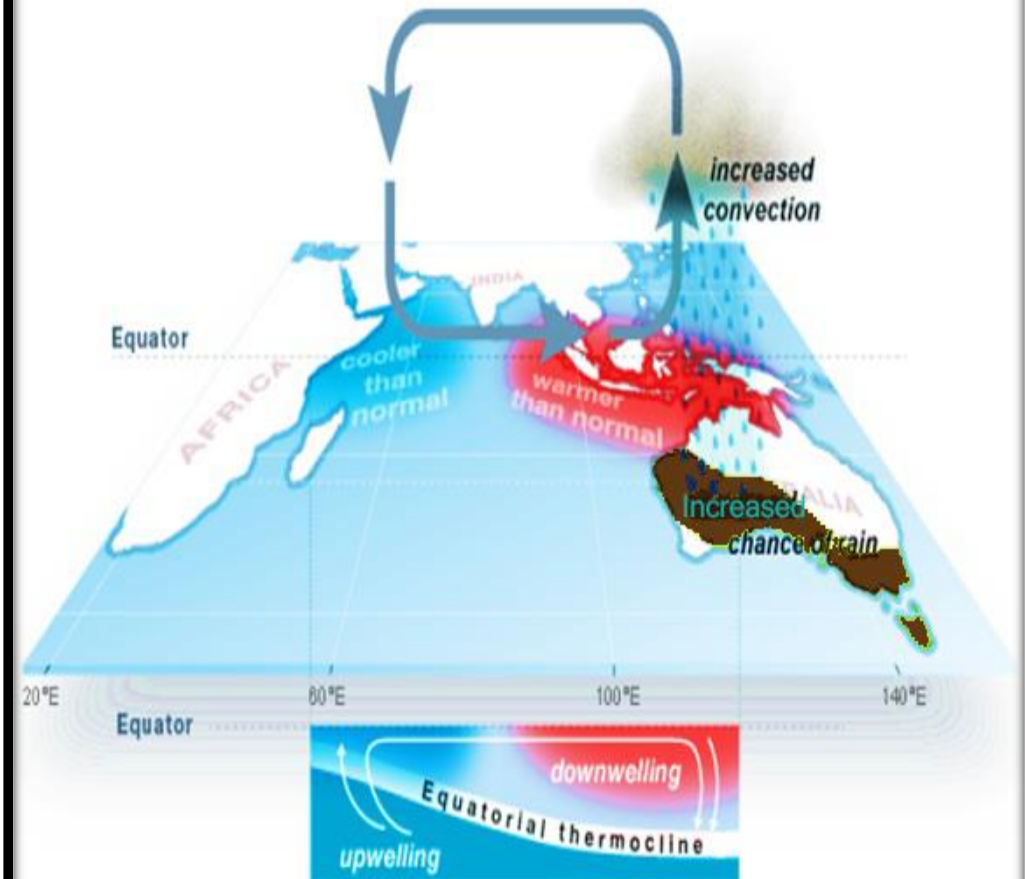
➤ **AEROSOLS**



INDIAN OCEAN DIPOLE

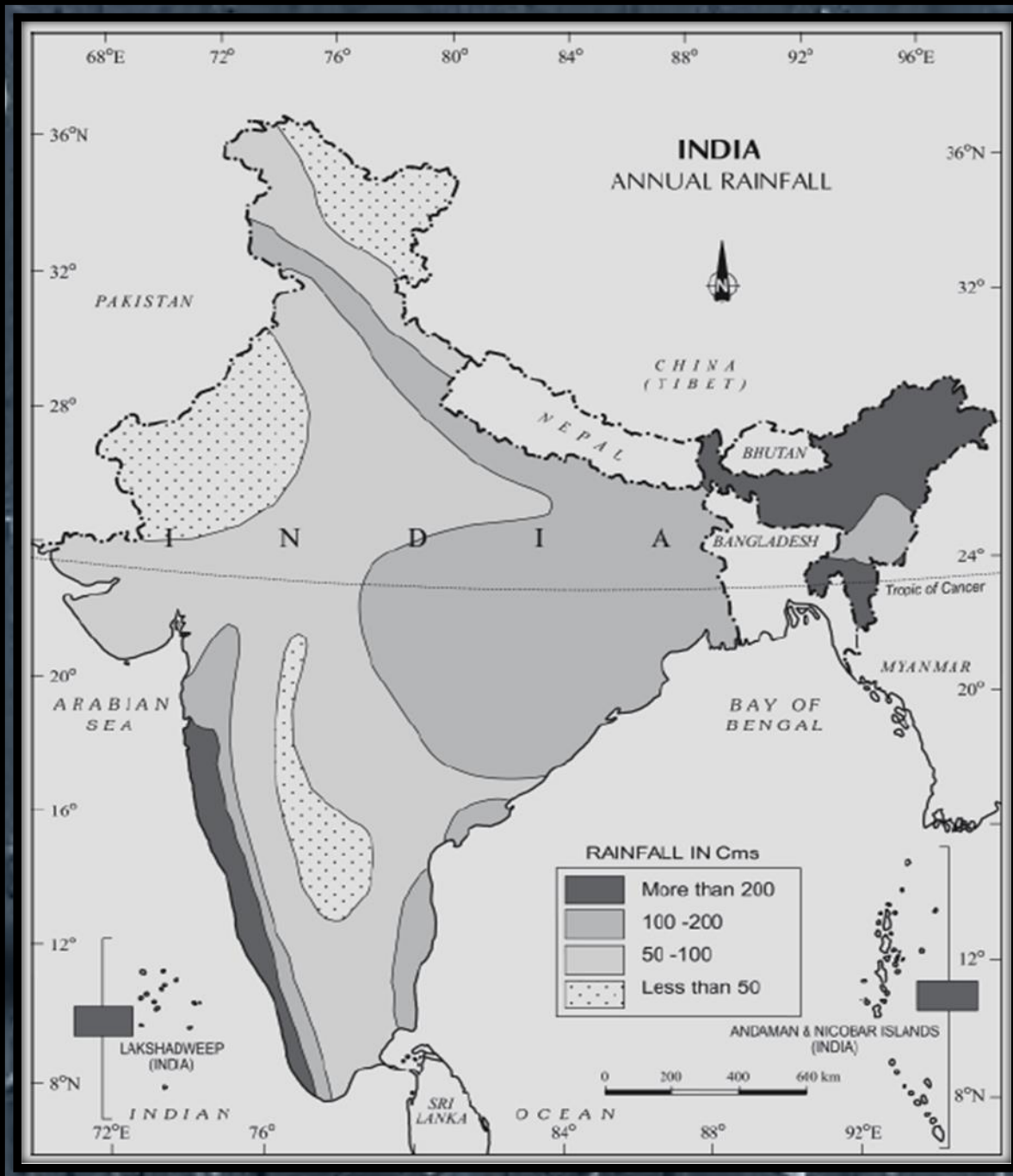


Indian Ocean Dipole (IOD): Positive phase



Indian Ocean Dipole (IOD): Negative phase

ANNUAL RAINFALL



CLIMATIC REGIONS IN INDIA

