GSSCORE

An Institute for Civil Services

MAINS TEST SERIES 2023

GS MAINS Q&A

TOPICAL TEST - 36

(5 QUESTION)

GEOGRAPHY

Geomorphology, Oceanography

GEOGRAPHY - 1

Time Allowed: 50 Mins. *Max. Marks: 75*

1. **Global warming has speeded up the oceanic currents and gyres which is reinforcing climate change and affecting marine life in an unprecedented manner. Discuss.**
2. **Discuss different types of igneous rocks on the basis of mode of occurrence and landforms associated with them.**
3. **Explain the process of subduction with reference to the Pacific ring of fire. Why does this process result in geo-hazards?**
4. **Coral reefs are bleaching at a faster rate in Lakshadweep due to a variety of reasons. Discuss.**
5. **Describe major relief features of the ocean floor. Also, explain in brief the roles of ocean relief.**

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GEOGRAPHY - 1

1. Global warming has speeded up the oceanic currents and gyres which is reinforcing climate change and affecting marine life in an unprecedented manner. Discuss.

Approach

1. ***The intro part of the question should consist of an overview of global warming and summarizing its various effects on the marine environment.***
2. ***Trace the impacts and challenges faced by the oceanic currents and gyres due to global warming, also discuss how it is further increasing the global warming.***
3. ***Give a brief conclusion with suggestions and a way forward.***

Hints:

The ocean is being disproportionately impacted by the increasing Global warming. The ocean absorbs most of the excess heat from greenhouse gas emissions, leading to rising ocean temperatures. Oceans absorbs carbon dioxide (CO_2) and other greenhouse gas emissions (GHG) from human activities. This causes changes in water temperature, ocean acidification and deoxygenation, speeded up the oceanic currents and gyres, leading to changes in oceanic circulation and chemistry, rising sea levels, increased storm intensity, as well as changes in the diversity and abundance of marine species.

Ocean Gyre:

- An ocean gyre is a large system of circular ocean currents formed by global wind patterns and forces created by Earth's rotation.
- The movement of the world's major ocean gyres helps drive the "ocean conveyor belt."
- The ocean conveyor belt circulates ocean water around the entire planet.
- It is also known as thermohaline circulation, the ocean conveyor belt is essential for regulating temperature, salinity and nutrient flow throughout the ocean.
- Forces behind the gyre circulation are global wind patterns, Earth's rotation, and Earth's landmasses.
- Ocean gyres are generally of three types: tropical, subtropical, and subpolar.

Global Warming Speeds up Oceanic Circulations:

- A group of Scientists recently discovered that past global warming has sped up deep ocean circulation using the geological records of the deep sea.
- So far, the ocean has absorbed a quarter of anthropogenic CO2 and over 90 percent of the associated excess heat.
- It was not assured whether global warming is slowing down the ocean circulation or speeding up.
- This inconsistency created a problem in making future predictions and estimations.

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- But, the present finding assured that global warming speeds up the ocean circulation and helped in resolving this controversy.
- However, the data obtained through satellites can Infomed Ocean models of only a few decades, hence limited knowledge can be acquired through these findings.
- This prompted us to look at the deep-sea geological record to decipher these changes.
- Ocean circulation has become more intense under the influence of global warming in the last few decades, found through this study.

Impact on Marine life:

- Increasing ocean temperatures affect marine species and ecosystems. Rising temperatures cause coral bleaching and the loss of breeding grounds for marine fishes and mammals.
- Rising ocean temperatures also affect the benefits humans derive from the ocean, threatening food security, increasing the prevalence of diseases and causing more extreme weather events and the loss of coastal protection.
- Achieving the mitigation targets set by the Paris Agreement on climate change and limiting the global average temperature increase to well below 2°C above pre-industrial levels is crucial to prevent the massive, irreversible impacts of ocean warming on marine ecosystems and their services.
- Establishing marine protected areas and putting in place adaptive measures, such as precautionary catch limits to prevent overfishing, can protect ocean ecosystems and shield humans from the effects of ocean warming.

Conclusion:

The recent finding is one of the missing links for predicting how future climate change may affect heat and carbon capture by the oceans. By combining results, we can conclude that warmer oceans not only have more vigorous deep circulation but are potentially also more efficient at storing carbon. Yet the study cautioned that we need to better understand how the ocean's capacity to store heat and carbon dioxide will be affected by future warming. A more comprehensive analysis of the geological history of ocean basins is needed to understand and verify this.

2. Discuss different types of igneous rocks on the basis of mode of occurrence and landforms associated with them.

Approach

1. ***Briefly define igneous rocks, its importance and various types of classifications***
2. ***Discuss the classification of igneous rocks on the basis of mode of occurrence with sub-classifications and examples***
3. ***Conclude with socio-economic importance of igneous rocks due to its varied utility***

Hints:

Igneous rocks are those rocks which are formed by cooling, solidification and crystallization of hot and molten materials called magma. They are also called primary rocks because they were originated first of all the rocks during formation of earth's surface after its origin. Also they have been termed as parent rocks because all other rocks are formed after their formation. Igneous rocks have been classified on the basis of various criteria such as texture and size of grain, amount of silica and on the basis of mode of occurrence.

Classification of igneous rocks on the basis of mode of occurrence:

I. **Intrusive igneous rocks:** Those igneous rocks which are formed when magma is solidified within the surface of the earth are called intrusive igneous rocks. Ex: diorite, gabbro, granite, pegmatite, and peridotite.

Intrusive igneous rocks are further classified into various categories such as:

i. **Plutonic Rocks:** These rocks are formed due to cooling of magma very deep inside the surface of the earth. They are of very large and coarse grain.

ii. **Hypabyssal igneous rocks:** Those rocks are formed due to cooling and solidification of magma during volcanic activity in the cracks, pores, cervices and hollow places just beneath the earth's surface are called Hypabyssal igneous rocks. Their main forms are:

   a) **Batholiths:** Dome shaped solidified, long irregular magma body with steep walls are batholiths.

   b) **Laccoliths:** Mushroom shaped igneous rock bodies having convex summital forms are called laccoliths.

   c) **Phacolithics:** Phacoliths are formed due to injection of magma along anticlines and synclines in the region of folded mountains.

   d) **Lopoliths:** These are saucer shaped intrusive igneous rock bodies.

   e) **Sills:** Sills are horizontal intrusive igneous rock bodies which are formed between the planes of parallel bedded sedimentary rocks. Thick beds of magmas are called sills where as thin beds are called sheets.

   f) **Dykes:** Dykes are wall like formations and are vertical or perpendicular to the bodies of sedimentary rocks.

II. **Extrusive Igneous Rocks:** Those rocks which are formed due to cooling of lava outside the earth's surface are called extrusive igneous rocks. These rocks include andesite, basalt, dacite, obsidian, pumice, rhyolite, scoria, and tuff.

Extrusive igneous rocks are of two types which are classified according to mode of occurrence:

a) **Explosive type:** These are those extrusive igneous rocks which are formed due to mixture of volcanic materials ejected during explosive type of violent volcanic eruptions are called explosive type extrusive igneous rocks.

Examples:

- **Bombs:** Big Fragments of rocks erupted during volcanic eruption
- **Lapilli:** Fragments of the size of peas. They along with volcanic dusts when are deposited in aquatic medium are called 'tuffs'.
- **Breccia or agglomerate:** They are mixture of small or larger particles and are formed after deposition. They are less consolidated.

b) **Quiet type:** These are formed after flow of lava on the surface of the earth and forms features such as lava plateaus and lava plains. Example: Columbia Plateau, Belts of Basaltic lava over Mahabaleshwar Plateau, Maharashtra.

c) **Volcanic mountains.**

Conclusion:

Igneous rocks are helpful in defining socio-economic status of a region due to its different utilities. Igneous rocks are used as building stone, facing stone and decorative material, such as that used for tabletops, cutting boards, and carved figures. Pumice is used as an abrasive material in hand soaps, emery boards, etc. Gneiss, Schist and Gabbro are very hard and widely used as crushed stone for concrete aggregate, road surfaces and railroad ballast. Igneous rocks may also contain many important ores such as tin or valuable minerals such as diamonds. Hence, they are mined at different regions around the world to be used for various purposes.

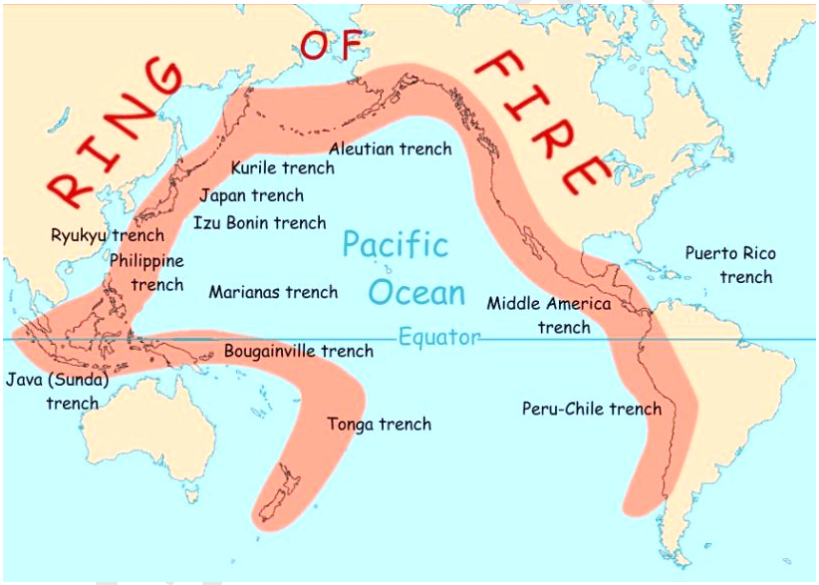
3. Explain the process of subduction with reference to the Pacific ring of fire. Why does this process result in geo-hazards?

Approach

1. ***In the introduction discuss the specifics of Pacific ring of fire and then define about the Subduction zones.***
2. ***In the body discuss the process of formation of subduction zone with reference to Pacific ring of fire.***
3. ***In detail discuss about the role of subduction process in resulting to a geo-hazards conditions.***
4. ***Conclude on the lines that Subduction zones are interior Earth systems of unparalleled complexity.***

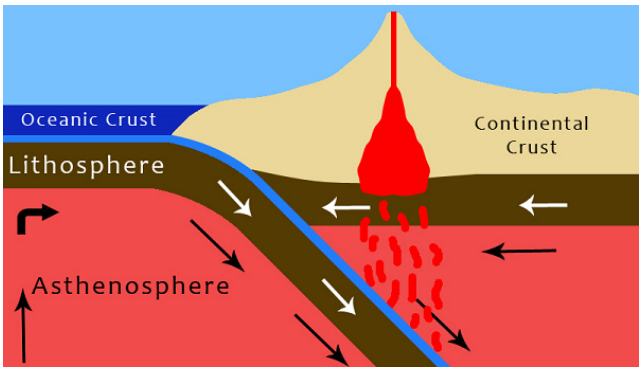
Hints:

The Ring of Fire is largely a result of plate tectonics, where the massive Pacific Plate interacts with less-dense plates surrounding it. It is a string of volcanoes and sites of seismic activity, or earthquakes, around the edges of the Pacific Ocean. Roughly 90% of all earthquakes occur along the Ring of Fire, and the ring is dotted with 75% of all active volcanoes on Earth.



Subduction is a kind of geological recycling. It occurs at convergent tectonic plate boundaries or where two tectonic plates come crashing together, in slow motion of course. At a convergent boundary, two plates can come together and rise up into mountains. This is how the impressive Himalayan Mountain range formed when India crashed into the rest of Asia. Another possibility for a convergent boundary is subduction. Instead of both plates crumpling upwards to form mountains, one sinks under the other and is recycled back into the mantle.

Process of subduction:



- **Convergent Boundaries:** A convergent plate boundary is formed by tectonic plates crashing into each other. Convergent boundaries are often subduction zones, where the heavier plate slips under the lighter plate, creating a deep trench. This subduction changes the dense mantle material into buoyant magma, which rises through the crust to the Earth's surface. Over millions of years, the rising magma creates a series of active volcanoes known as a volcanic arc.
- **Divergent Boundaries:** A divergent boundary is formed by tectonic plates pulling apart from each other. Divergent boundaries are the site of seafloor spreading and rift valleys. Seafloor spreading is the process of magma welling up in the rift as the old crust pulls itself in opposite directions. Cold seawater cools the magma, creating new crust. The upward movement and eventual cooling of this magma has created high ridges on the ocean floor over millions of years.
- **Transform Boundaries:** A transform boundary is formed as tectonic plates slide horizontally past each other. Parts of these plates get stuck at the places where they touch. Stress builds in those areas as the rest of the plates continue to move. This stress causes the rock to break or slip, suddenly lurching the plates forward and causing earthquakes. These areas of breakage or slippage are called faults. The majority of Earth's faults can be found along transform boundaries in the Ring of Fire.

Why subduction results in geo-hazards?

- **Earthquake Activity:** The movement of continental and oceanic plates does not go unnoticed on the surface of the earth. The explanation of subduction perhaps makes the process sound relatively smooth, with one plate slowly sinking and falling off into the mantle layer below.
  - Most scientists, however, describe subduction as a rough, scraping activity that is characterized by high amounts of friction as the two plates rub past each other. As the subducting slab moves under the less dense plate, some of its pieces may become caught on the upper plate.
- **Volcanic Activity:** Another side effect of the subduction process is the creation of volcanoes, as well as increased volcanic activity above subduction zones. These subductions zone-created volcanoes occur in one of two formations: island arc or continental arc.
  - An island arc results when one oceanic plate moves under another oceanic plate. A continental arc results when an oceanic plate moves under a continental plate.
  - **For example:** Three-quarters of the volcanic activity on earth is confined to an area known as the **Pacific Ring of Fire**. This ring moves along the western coastlines of the Americas and along the eastern coastlines of Asia and the Pacific Islands, forming an upside down u-shape.
- **Tsunamis:** In addition to earthquakes and volcanic activity, the process of subduction is also credited with causing severe tsunamis around the world. Tsunamis, large and dangerous waves, are the result of earthquakes (and other geologic activity) on or near coastlines.
  - Because subduction zones are typically located along coastlines, the resulting earthquakes caused by the tectonic plate movement often cause tsunami waves to ravage coastal environments and urban settlements.

Conclusion:

Subduction zones are central for understanding what drives plate motions and how continental crust is formed. Recycling at subduction zones is key to understanding chemical fluxes between Earth's surface and interior, with profound implications for understanding long-term climate change.

4. Coral reefs are bleaching at a faster rate in Lakshadweep due to a variety of reasons. Discuss.

Approach

1. The intro part of the question should consist with defining the Coral bleaching and the various factors associated with it.

2. Discuss the reasons behind the faster rate of coral bleaching in Lakshadweep Island.

3. Conclude briefly with suggestions.

Hints:

When ocean waters remain warm for too long, the corals become stressed and expel the colorful seaweeds that live inside their tissues, called zooxanthellae. Zooxanthellae provide coral with food and energy from the sun (due to a process called photosynthesis), allowing them to grow and reproduce. When corals become stressed by things like heat or pollution, they react by expelling this algae, leaving behind a white skeleton. This is known as 'coral bleaching'. Some corals can feed themselves, but without zooxanthellae, most corals starve to death. A healthy reef can recover from coral bleaching, but it requires time and the right conditions. It takes about a decade for corals to fully recover.

Reasons for Coral Bleaching:

- The primary cause of coral bleaching is climate change.
- Global warming mostly influences oceans, as the heat is absorbed by the oceans, and transformed into heat sinks.
- Warming ocean means a change in water temperature, as little as 2 degrees celsius can cause coral to drive out algae.
- Corals may bleach for other reasons as well like extremely low tides, pollution, or too much sunlight.
- Impact of Coral bleaching further propagates to other corals as well leading them to expel zooxanthellae.
- Coral bleaching matters because once these corals die, reefs rarely come back.
- However, few corals surviving, struggle to reproduce, and entire reef ecosystems, on which people and wildlife depend, deteriorate.

Faster Rate of Bleaching in Lakshadweep:

- The Lakshadweep islands consist of 12 atolls and several submerged coralline banks.
- In 1988, the island saw a severe rise in temperature, it rose by 1 to 20C above the seasonal maximum.
- Due to this big rise, nearly 80 per cent of the coral areas in the island were affected.
- In recent times, anthropogenic impacts such as over-exploitation, overfishing, increased sedimentation and nutrient excess have worsened the situation.
- Natural disturbances, such as violent storms, flooding, high and low temperature extremes, El Nino Southern Oscillation (ENSO) events, sub-aerial exposures, predatory outbreaks and epizootics cause severe damage to the coral reefs.
- High elevated temperature causes mass bleaching of corals leading to a rapid loss of pigmentation of coral and whitening of the colony.
- Due to increasing environmental pollution, scattered sunlight reaches the surface of the earth, thereby inhibiting the process of photosynthesis.

Conclusion:

The elevated Sea surface temperature of tropical oceans by more than 3 ! and delayed monsoon seasons can trigger widespread bleaching in coral reefs. The Agatti reefs showed an average of 73% bleached corals, with apparent bleaching related mortality of sea anemones and giant clams. It is essential that continuous monitoring programs are undertaken to measure changes in Lakshadweep coral areas, raise public awareness and establish an effective management system for conservation and protection of the coral reef ecosystem.

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5. *Describe major relief features of the ocean floor. Also, explain in brief the roles of ocean relief.*

Approach

1. ***Introduction on major ocean relief***
2. ***Explain major relief features of the ocean floor such as continental shelf, abyssal Plains, abyssal hills etc.***
3. ***Discuss Roles of Ocean Relief***
4. ***Conclusion***

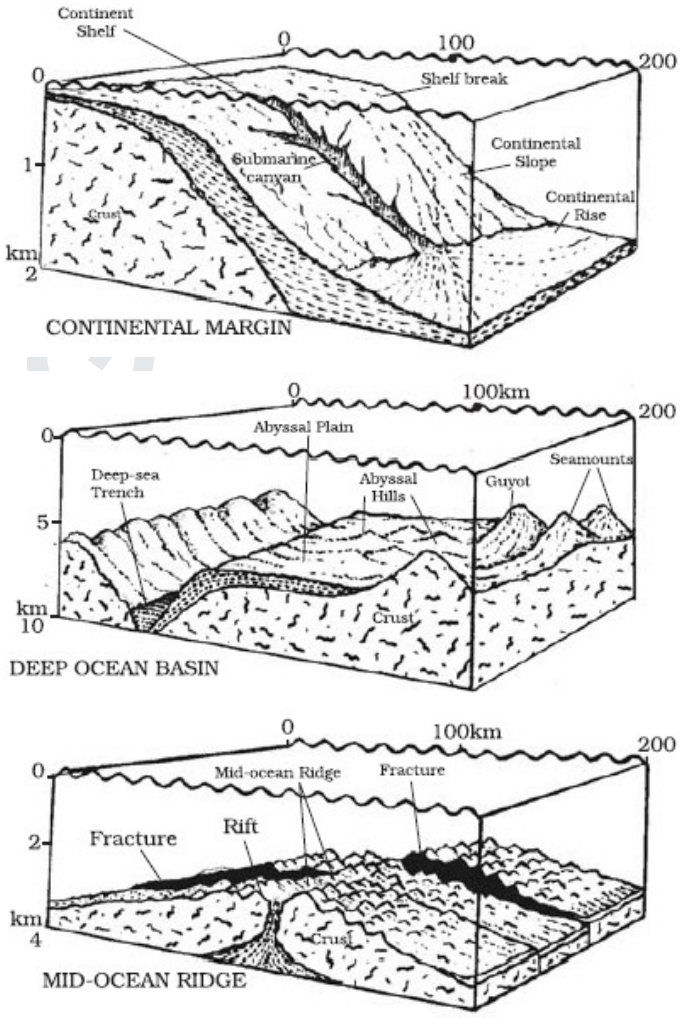
Hints:

About 71% of the earth's surface is covered by water (3/5th of the Northern Hemisphere and 4/5th of the Southern Hemisphere is covered by water). Oceans contain a variety of landforms.

Ocean relief is largely due to tectonic, volcanic, erosional and depositional processes and their interactions. A major portion of the ocean floor is found between 3-6 km below the sea level. The 'land' under the waters of the oceans, that is, the ocean floor exhibits complex and varied features as those observed over the land. The floors of the oceans are rugged with the world's largest mountain ranges, deepest trenches and the largest plains

The ocean floors can be divided into four major divisions: (i) the Continental Shelf; (ii) the Continental Slope; (iii) the Deep Sea Plain; (iv) Oceanic Deeps. Besides these divisions there are also major and minor relief features in the ocean floors like ridges, hills, sea mounts, guyots, trenches, canyons, etc.

Major relief features of the ocean floor



- **Continental Shelf:** This is a gentle seaward sloping surface extending from the coasts toward s the open sea. In all, about 7.5% of the total area of the oceans is covered by the continental shelves. The shelf is formed by the drowning of a part of a continent with a relative rise in sea level or marine deposition beneath the water. The continental shelves are mostly covered by sediments of terrestrial origin. There are various types of shelves—glaciated shelf, coral reef shelf, shelf of a large river, shelf with dendritic valleys and the shelf along young mountain ranges. The shelves are of great use to man
  - Marine food comes almost entirely from them
  - They provide the richest fishing grounds
  - They are potential sites for economic minerals; already, about 20% of the world production of petroleum and gas comes from shelves
  - They are large stores of sand and gravel.
- **Continental Slope:** As the continental shelf nears its seaward edge, the gradient becomes steeper—two to five degrees. This is the site of the continental slope which descends to a depth of 3,500 metres and joins the shelf to the deep ocean floor. The site of the slope also indicates the end of the continental block. The slopes may be furrowed by canyons and trenches.
- **Continental Rise:** The continental slope gradually loses its steepness with depth. When the slope reaches a level of between 0.5° and 1°, it is referred to as the continental rise. With increasing depth the rise becomes virtually flat and merges with the abyssal plain.
- **Abyssal Plains:** Beyond the continental rise, at depths from 3,000 m to 6,000 m, lie the deep sea plains, called abyssal plains or abyssal floors. Covering nearly 40% of the ocean floor, the abyssal plains are present in all major oceans and several seas of the world. They are uniquely flat with a gradient of less than 10,000. The large supply of terrigenous and shallow water sediments buries the irregular topography to form a generally flat relief.
- **Submarine Ridges:** Submarine ridges are mountain ranges, a few hundred kilometres wide and hundreds and often thousands of kilometres in length on the floors of oceans. Running for a total length of 75,000 km, these ridges form the largest mountain systems on earth. These ridges are either broad, like a plateau, gently sloping or in the form of steep-sided narrow mountains. These oceanic ridge systems are of tectonic origin and provide evidence in support of the theory of Plate Tectonics.
- **Abyssal Hills:** These are elevated features of volcanic origin. A submarine mountain or peak rising more than 1,000 metres above the ocean floor is known as a seamount. The flat topped mountains are known as guyots. Seamounts and guyots are very common in the Pacific Ocean where they are estimated to number around 10,000.

Roles of Ocean Relief

- Ocean relief can control the motion of sea water as it has various depths and widths as well.
- The movement in ocean currents can cause many variations in both oceans and in the atmosphere.
- Ocean relief, which takes places at the bottom of the ocean, can influence navigation and fishing. At this point, the different features of ocean relief may provide different marine creatures.

Conclusion:

Mapping the characteristics of the ocean basin has been difficult for several reasons. First, the oceans are not easy to travel over; second, until recent times navigation has been extremely crude, so that individual observations have been only loosely correlated with one another; and, finally, the oceans are opaque to light—that is, the deep seafloor cannot be seen from the ocean surface. Various technologies have emerged such as Single Beam Echo-Sounders (SBES), Multibeam Echo-Sounders (MBES), Satellite-Derived Bathymetry (SDB), Light Detection and Ranging (LIDAR), etc which have made possible a finer and detailed study of ocean relief features.