

Marine Geology Lecture Two

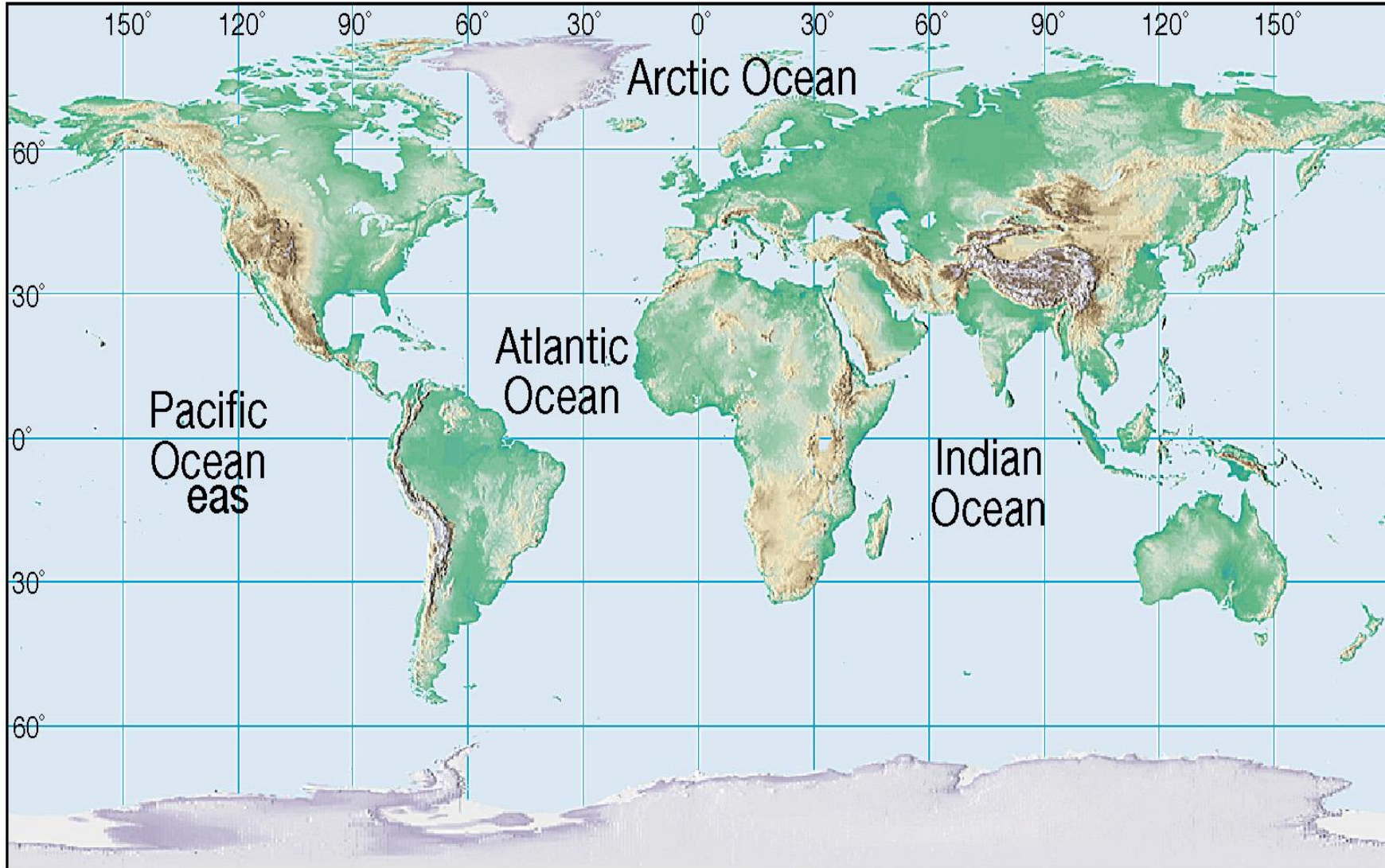
Morphology of the Ocean
Prof M A Omran

The vast world ocean

❖ Four main ocean basins

- Pacific Ocean - the largest ($181 \times 10^6 \text{ km}^2$) and deepest (11 Km), the mean depth is 3700 m.
- Is surrounded by linear mountain chains, trenches and island arc systems.
- Contains large numbers of volcanic island and extensive marginal basins.
- Atlantic Ocean – about half the size of the Pacific Ocean ($94 \times 10^6 \text{ km}^2$), about 500 km wide, marked by north – south extension and link two polar oceans.
- It serves as an avenue for cold waters produced in the polar oceans.
- Slightly shallow with a mean of 400 m depth to a maximum 4 km.
- Indian Ocean – slightly smaller than the Atlantic
- Arctic Ocean – about 7 percent the size of the Pacific

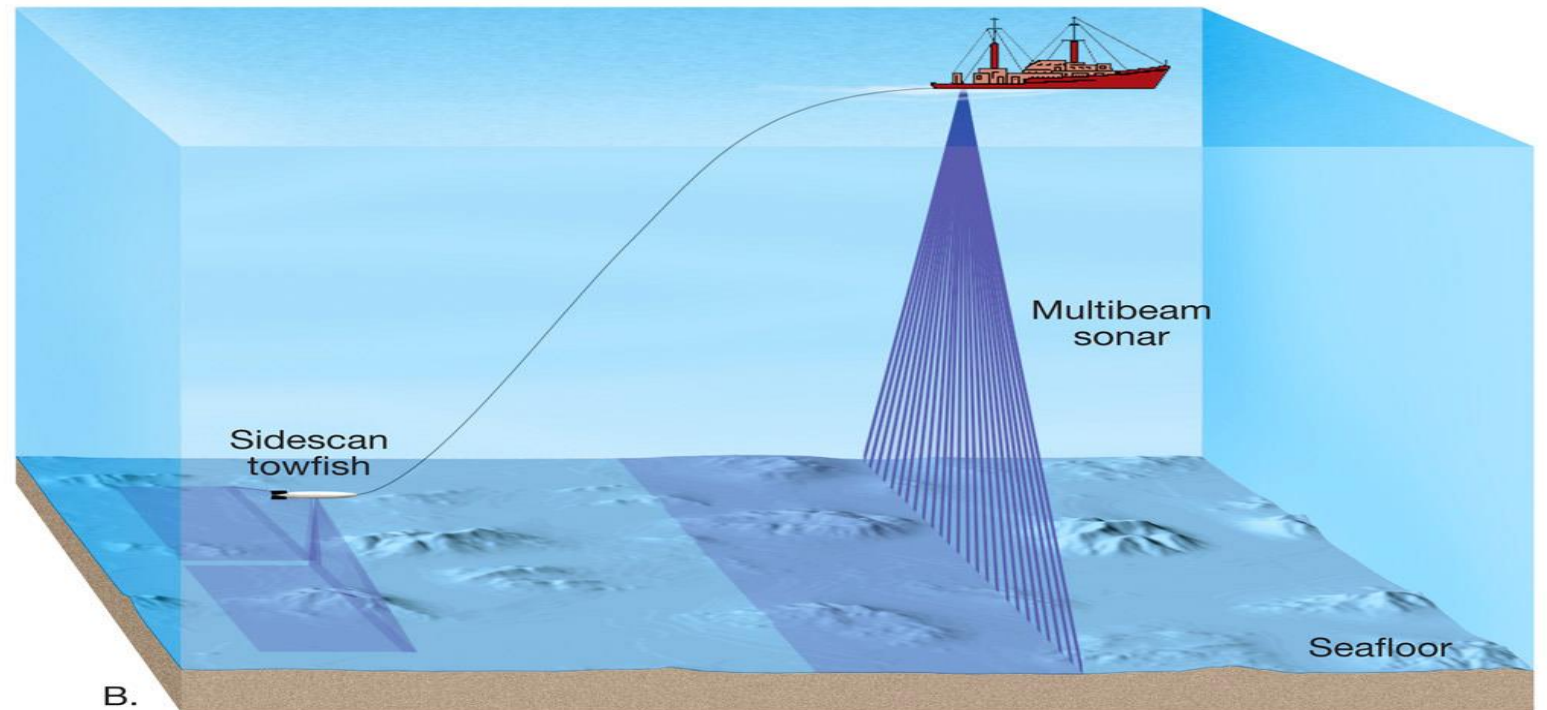
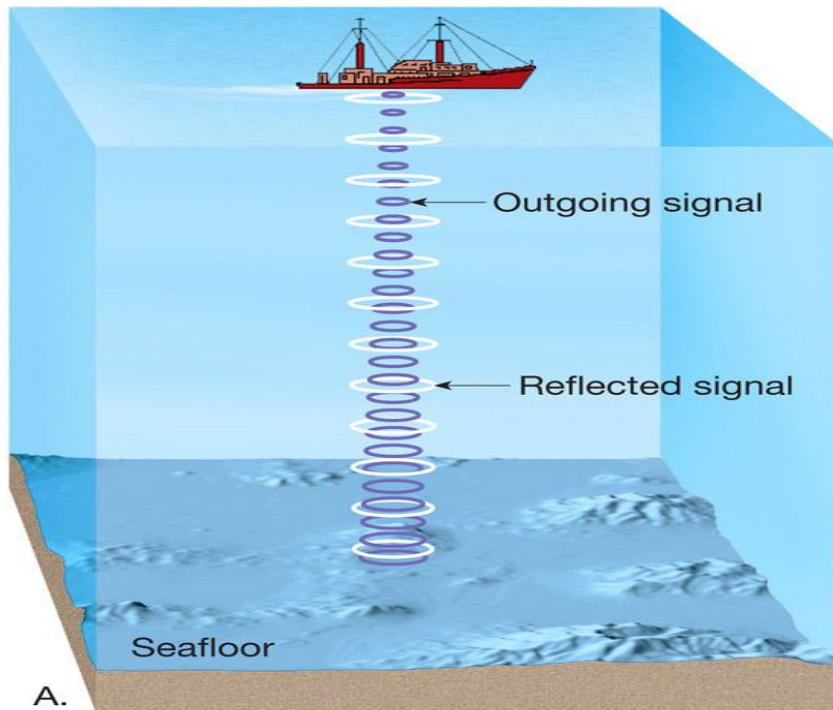
The oceans of Earth



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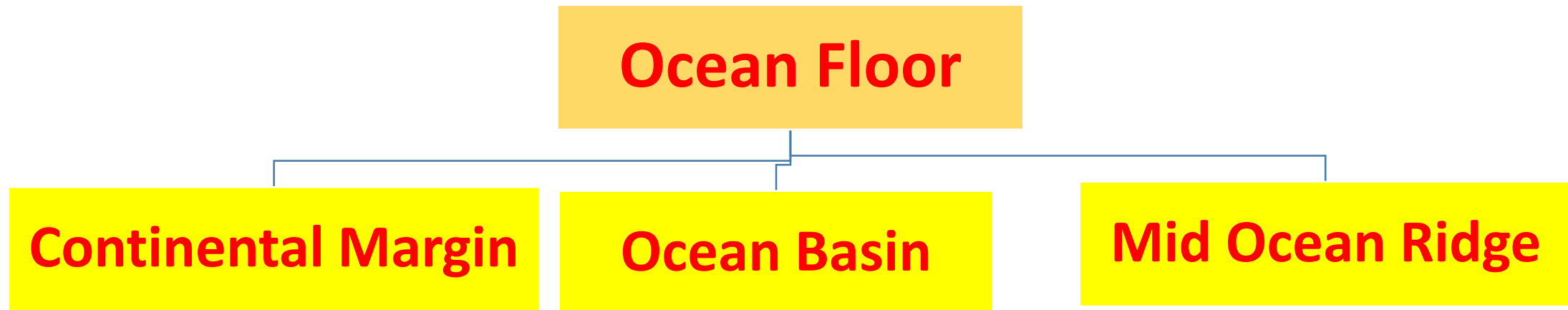
Mapping the ocean floor

- ❖ Bathymetry – measurement of ocean depths and the shape or topography of the ocean floor
- ❖ Echo sounder (also referred to as sonar)
 - Invented in the 1920s
 - Primary instrument for measuring depth
 - Reflects sound from ocean floor



Topography

- Is the study of Earth's surface shape and features.
- **Ocean topography is the study of the ocean floor and the features of which.**
- The ocean floor divided into Three major regions:

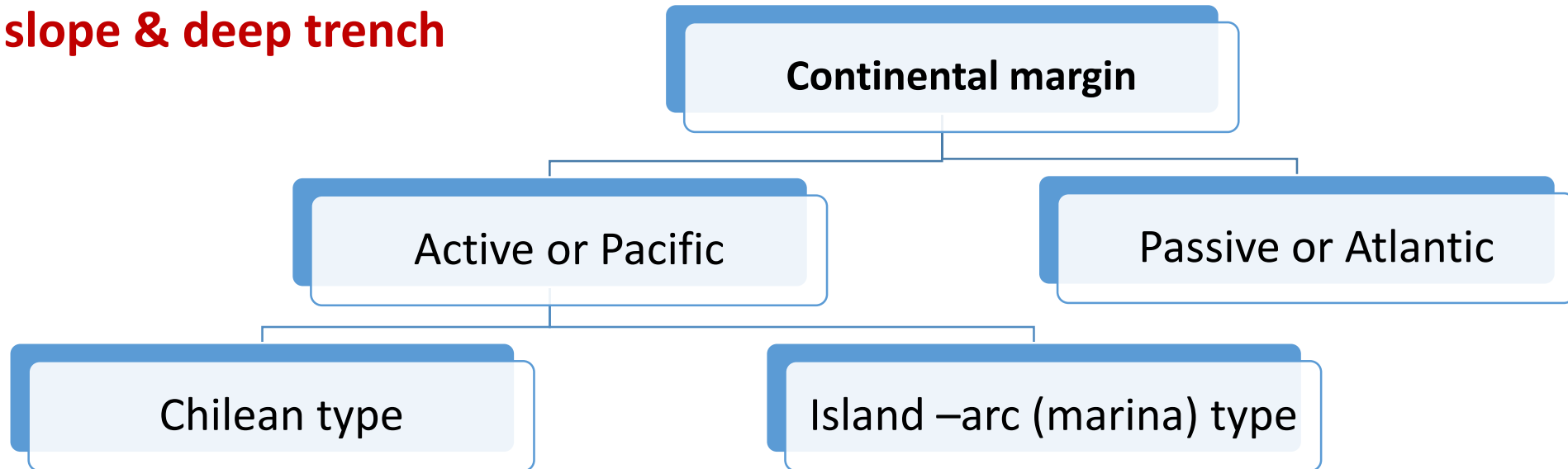


Three major topographic units of the Ocean floor

1. Continental margins:

continental margin lie between continents and ocean basins and include all the features between them. Represent 20% of ocean area.

- Passive margins or Atlantic type margin; consists of:
continental shelf, continental slope & continental rise
- Active margins or Pacific type margin; consists of:
shelf, slope & deep trench



2. Ocean basin floor

❖ **Abyssal plains**

- Likely the most level places on Earth
- Sites of thick accumulations of sediment
- Found in all oceans

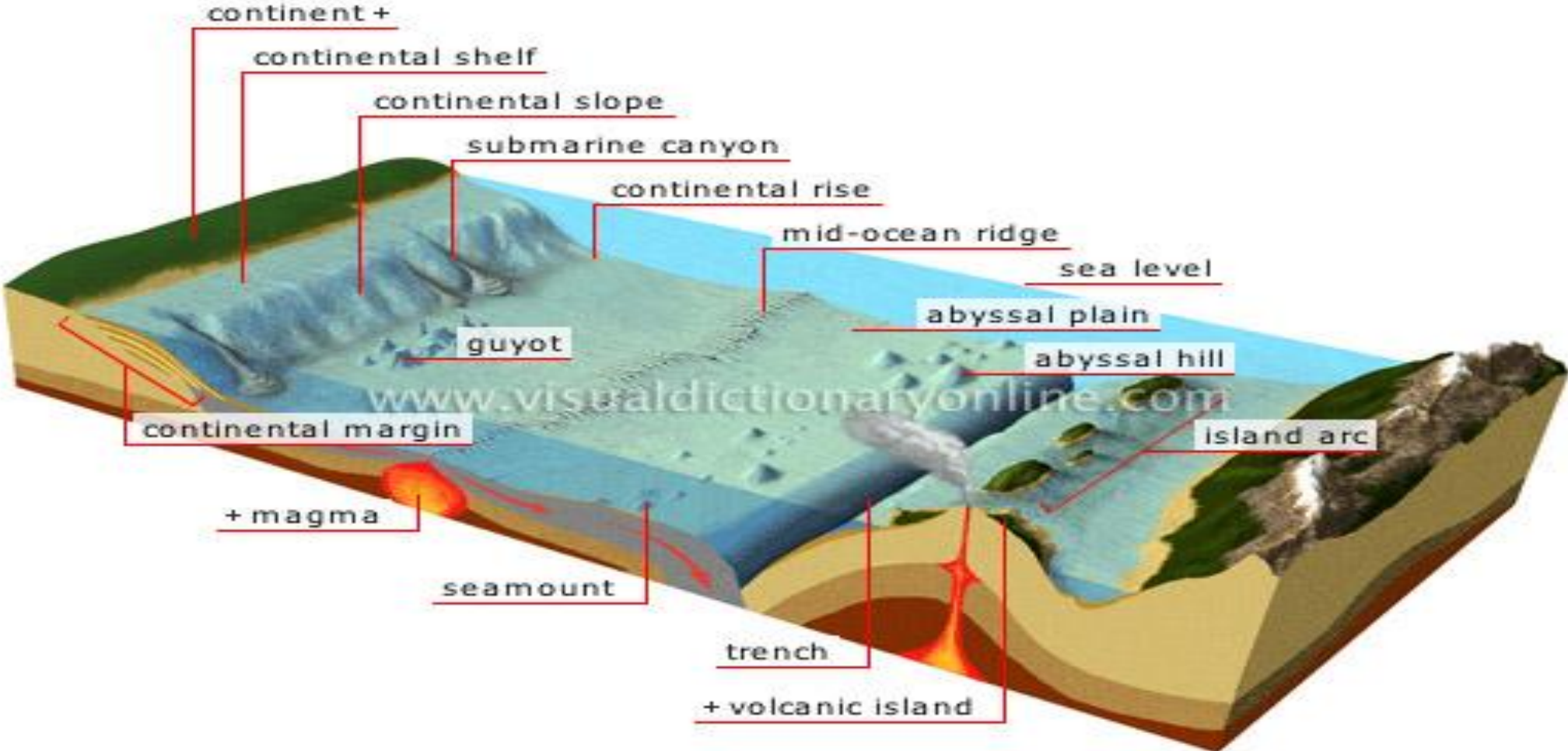
❖ **Seamounts and guyots**

- Isolated volcanic peaks
- Many form near oceanic ridges

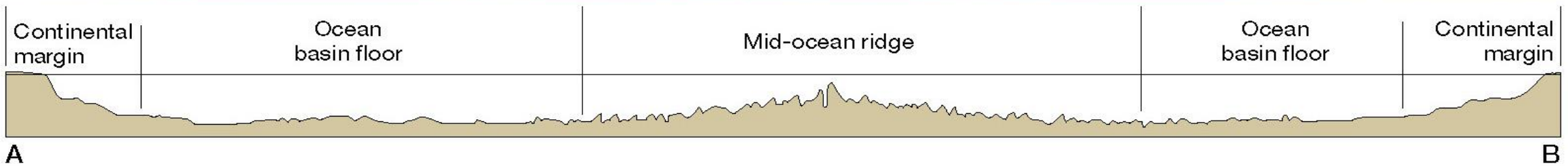
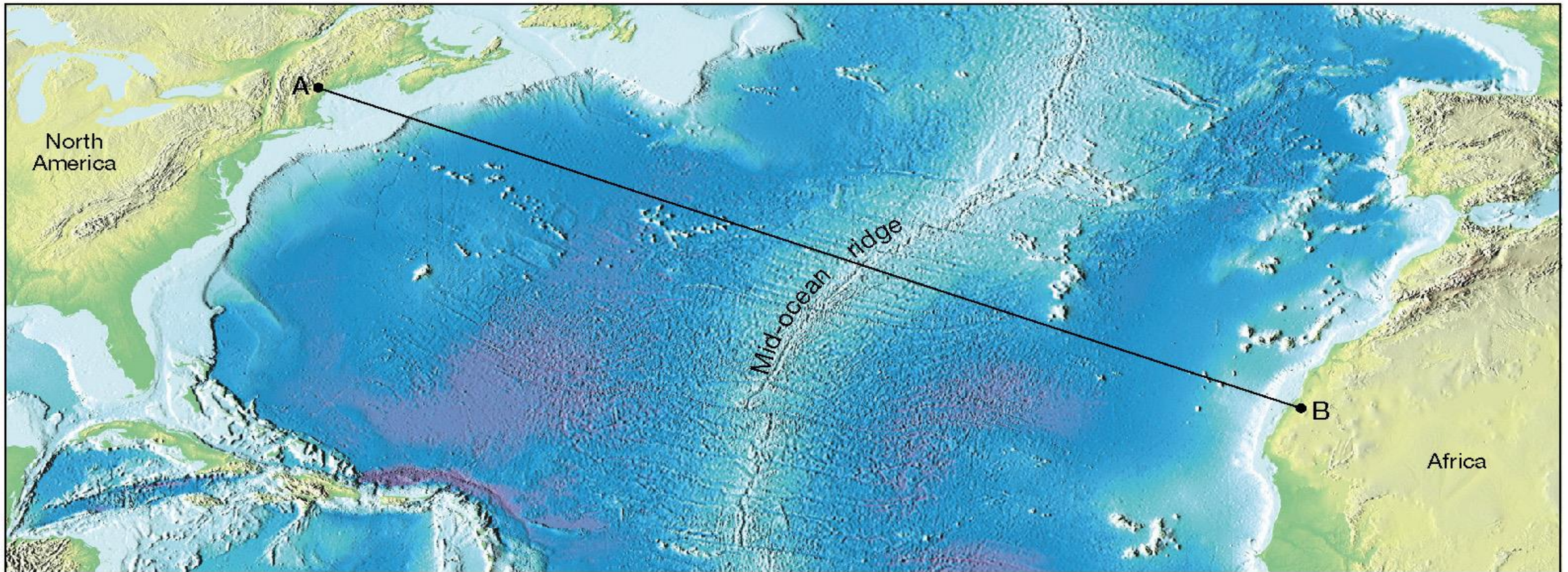
3. Mid-ocean ridge

- Mid-ocean ridge Characterized by:
- An elevated position
- Extensive faulting
- Numerous volcanic structures that have developed on newly formed crust

Main features of Ocean Floor



Major topographic divisions of the North Atlantic Ocean

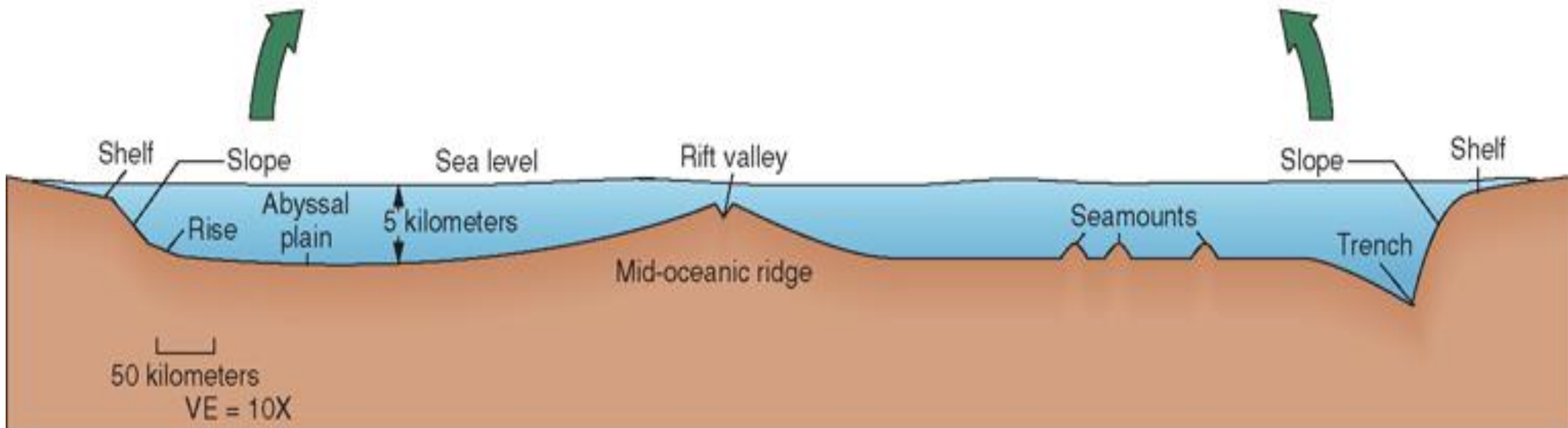
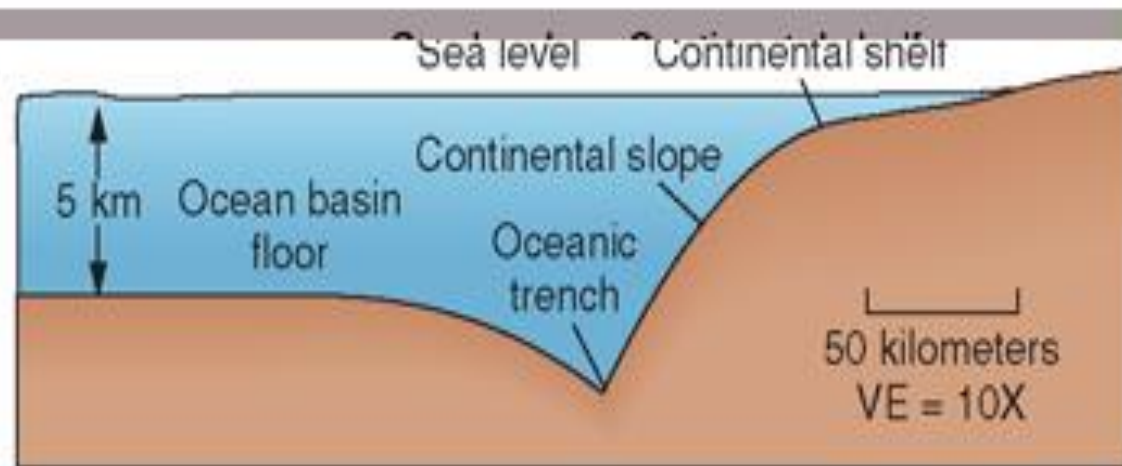
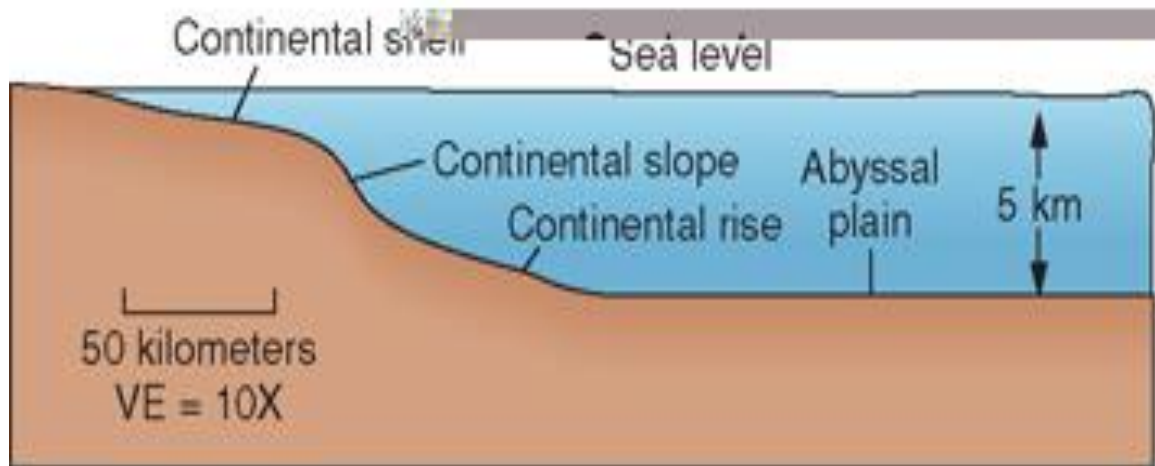


Features of the Sea Floor

- *Passive continental margins* have a *continental shelf*, *continental slope*, and *continental rise* descending to the *abyssal plain*
- *Active continental margins* have continental shelves and slopes, but the slope extends down into a deep *oceanic trench*
- A *mid-oceanic ridge* system encircles the globe, typically running down the center of oceans
- Numerous conical *seamounts* rise from the deep ocean floor

PASSIVE CONTINENTAL MARGIN

ACTIVE CONTINENTAL MARGIN

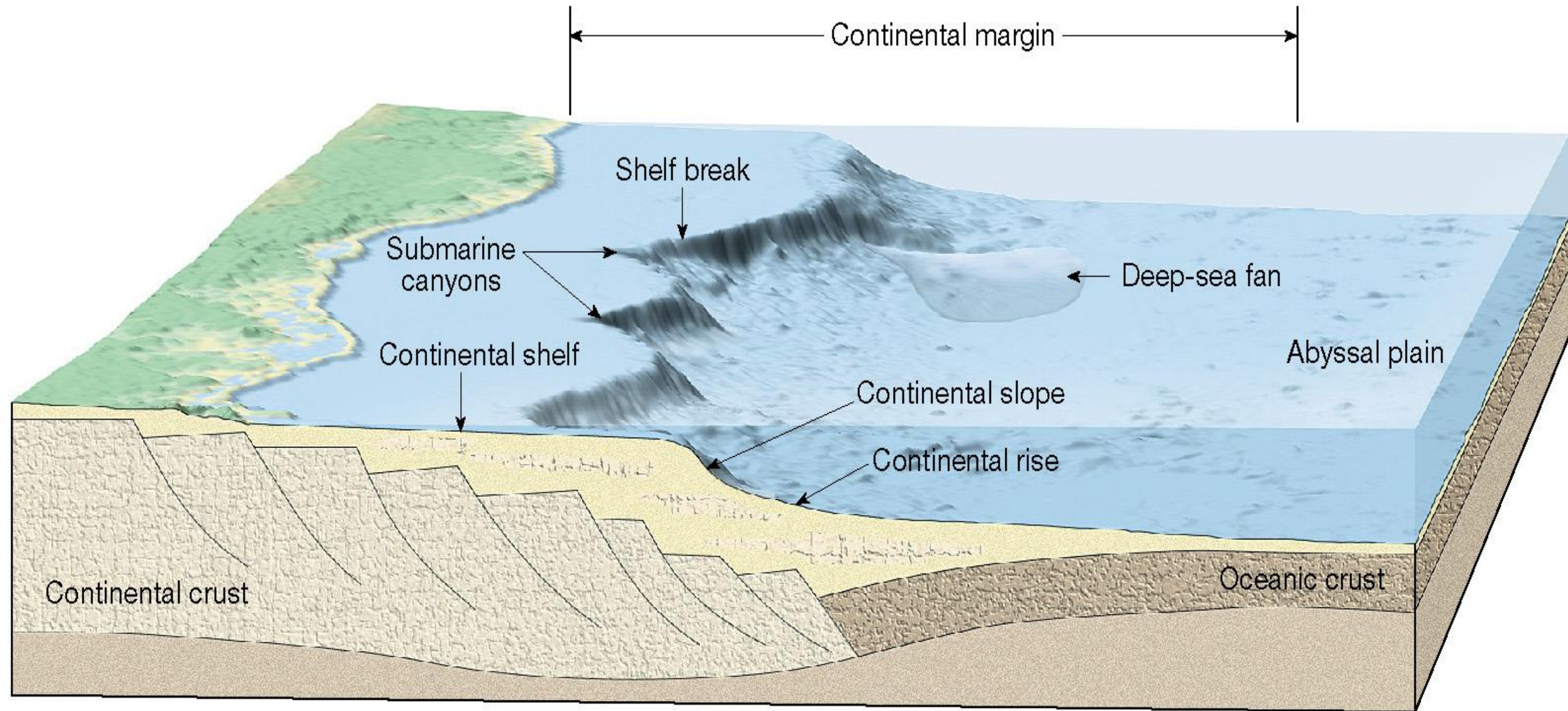


1 - Continental margins

❖ Passive (Atlantic type/ aseismic) continental margins

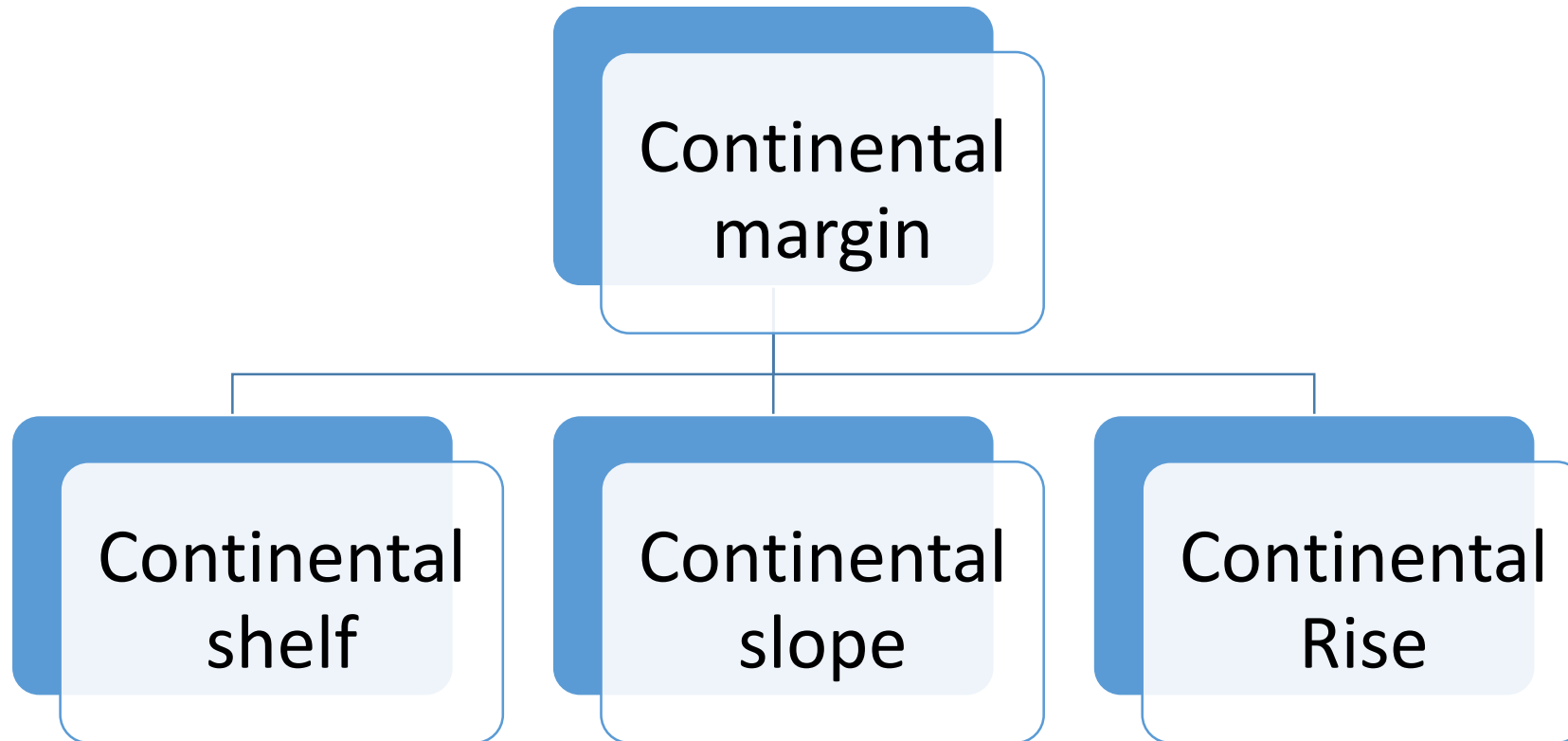
- **Found along most coastal areas that surround the Atlantic Ocean**
- **Not associated with plate boundaries**
 - **Experience little volcanism and**
 - **Few earthquakes**
 - **Wider sandy beaches**

Features of a passive continental margin



Passive continental margins;

Comprises three features:

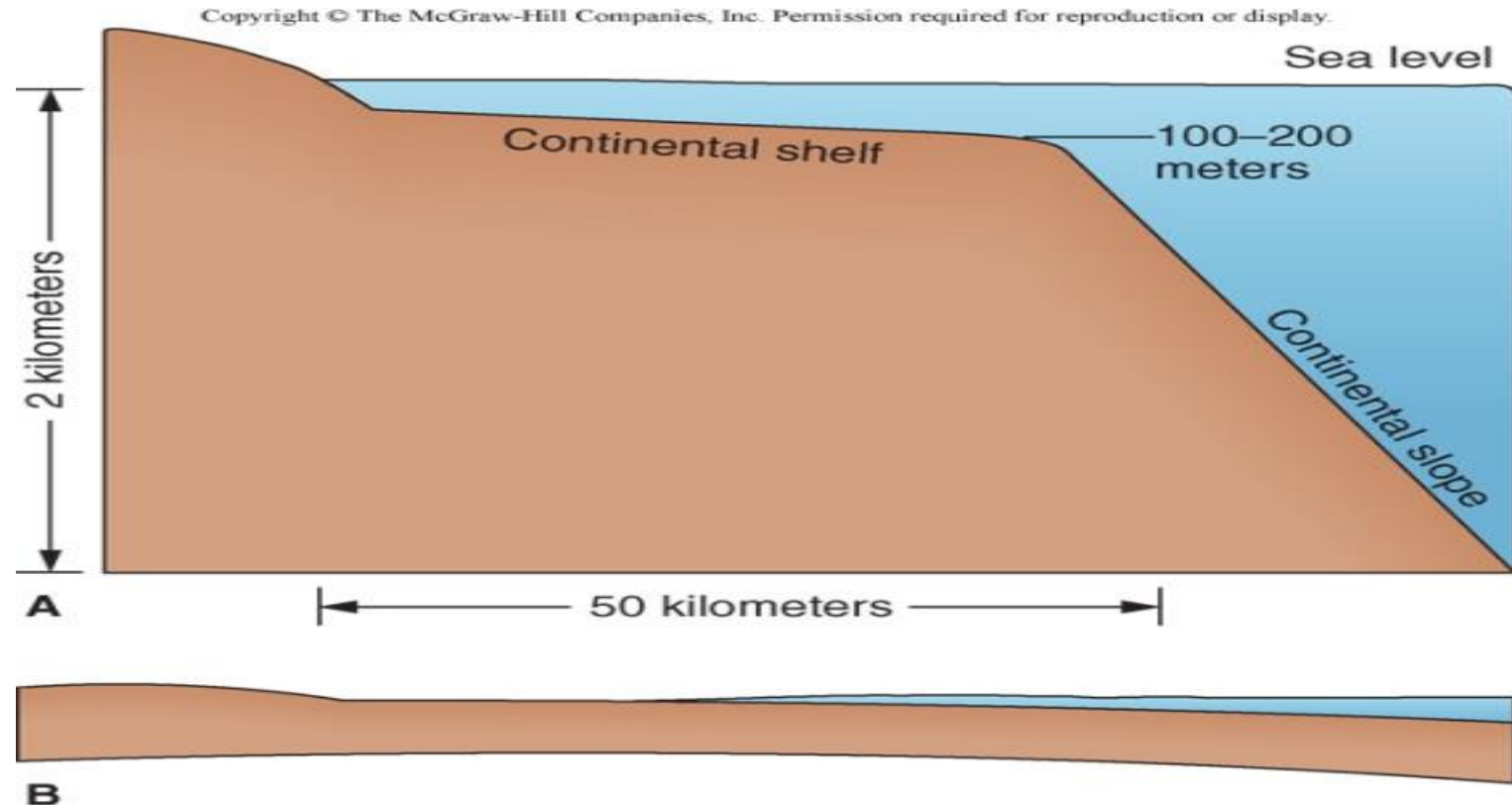


Passive continental margins

- Features comprising a **passive** continental margin

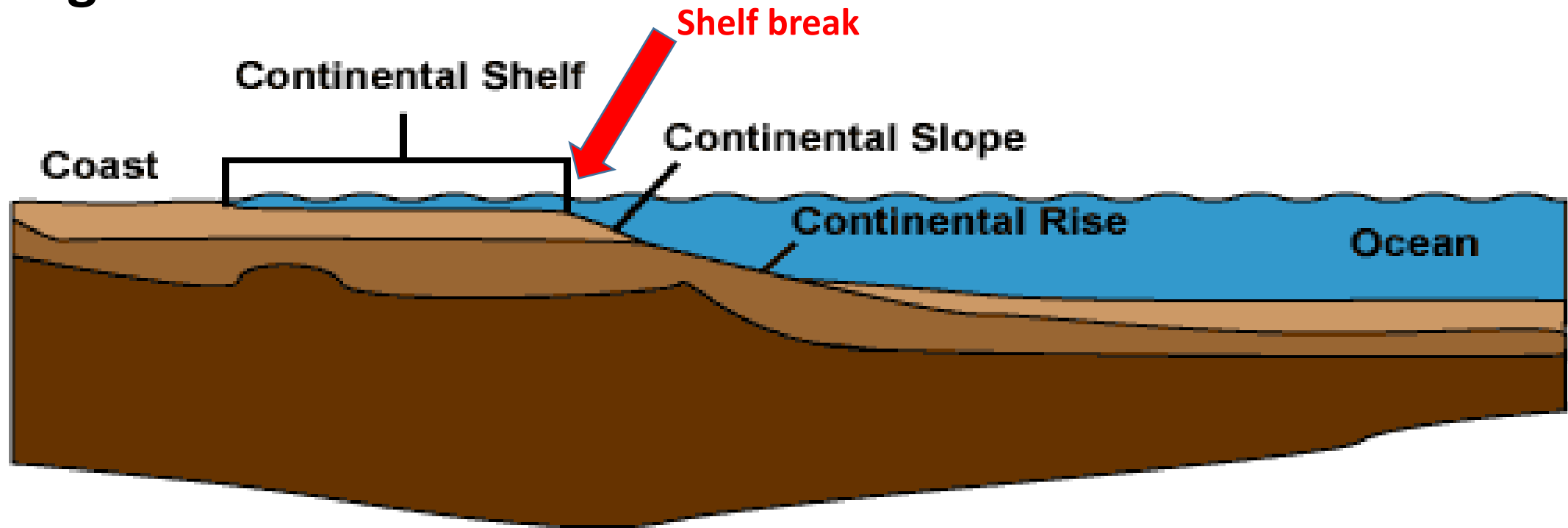
1. Continental shelf

- **Flooded extension of the continent**
 - **Contains oil and important mineral deposits**
- ***Continental shelves*** –
 - **gently dipping (0.1°) seaward-sloping**
 - **shallow submarine platforms at the edges of continents**
 - **Range in width from a few km to >500 km**
 - **Typically covered with young sediments**



Continental shelf

- The continental shelf is the extended perimeter of each continent and associated coastal plain, and was part of the continent during the glacial periods, but is undersea during interglacial periods.
- The shelf break area marks the increase of slope at the outer margin



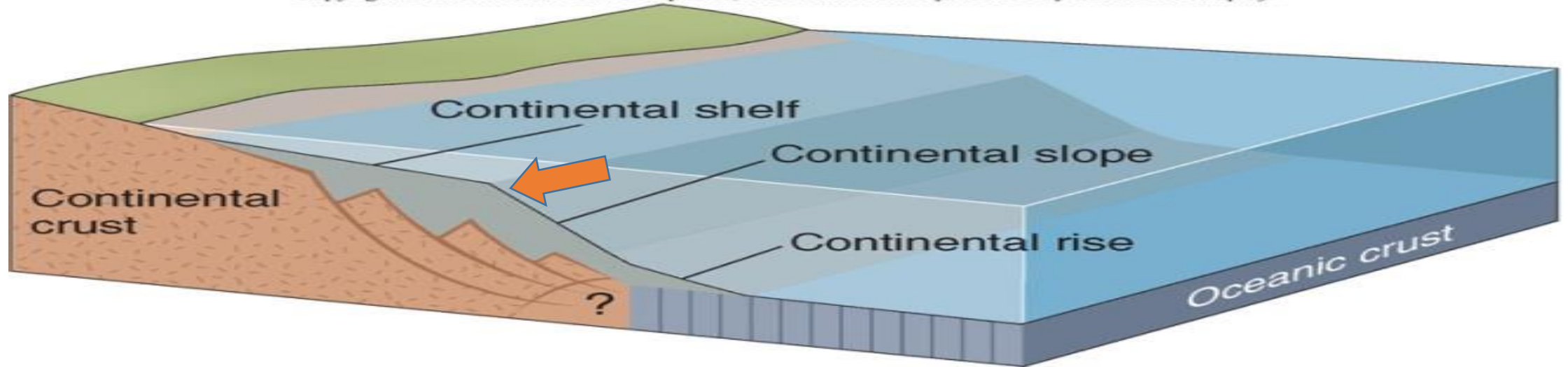
Passive continental margins

- Features comprising a passive continental margin

2. Continental slope

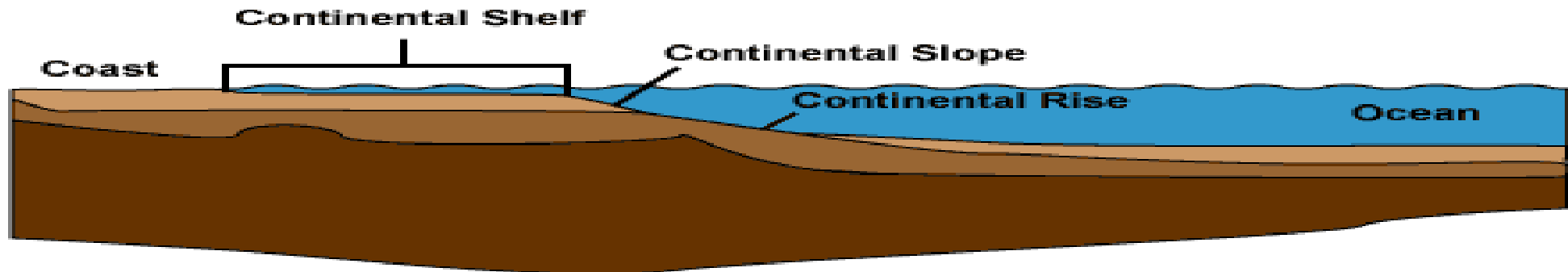
- Marks the seaward edge of the continental shelf
- **Relatively steep structure**
- Submarine canyons and turbidity currents
- **relatively steep slopes (typically 4-5°, but locally much steeper) that extend down from the edge of the continental shelf to the abyssal plain**

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Continental slope

- **The descending slope which connects the sea floor to the Continental shelf. This is still considered to be part of the Continent.**
 - Marks the seaward edge of the continental shelf
 - Relatively steep structure
 - Submarine canyons and turbidity currents Found in regions where trenches are absent
 - Continental slope merges into a more gradual incline – the continental rise
 - Thick accumulation of sediment



Continental margins

❖ Passive continental margins

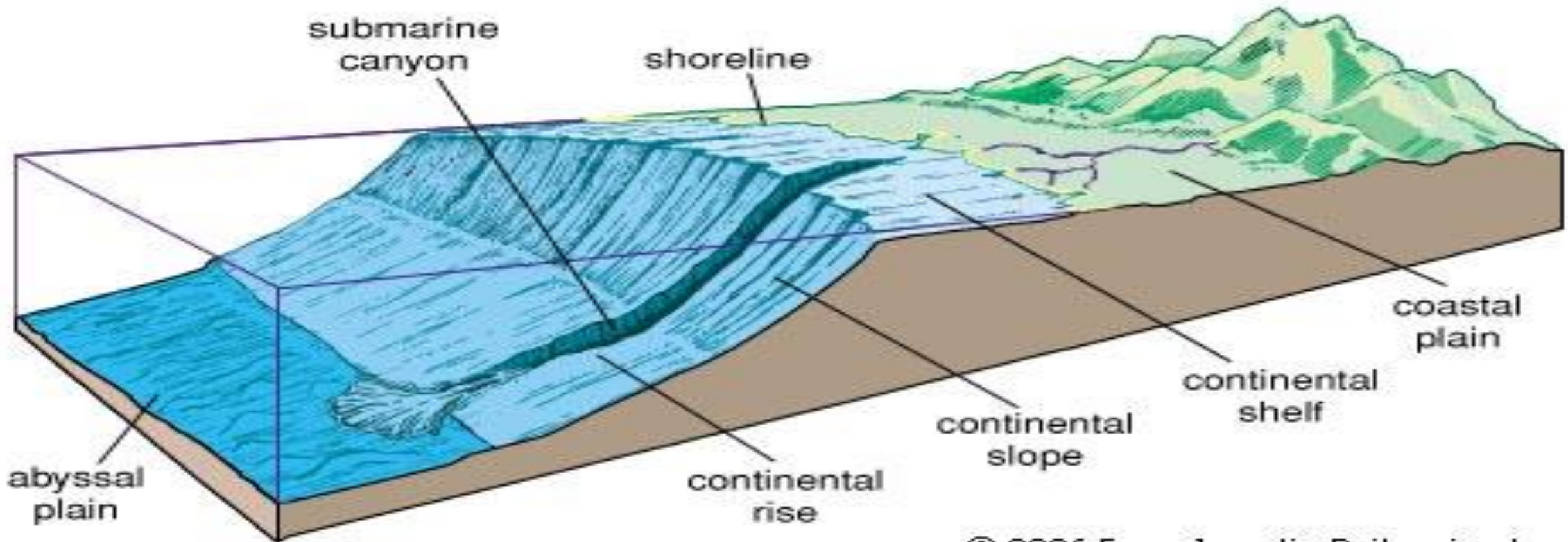
- Features comprising a passive continental margin

3. Continental rise

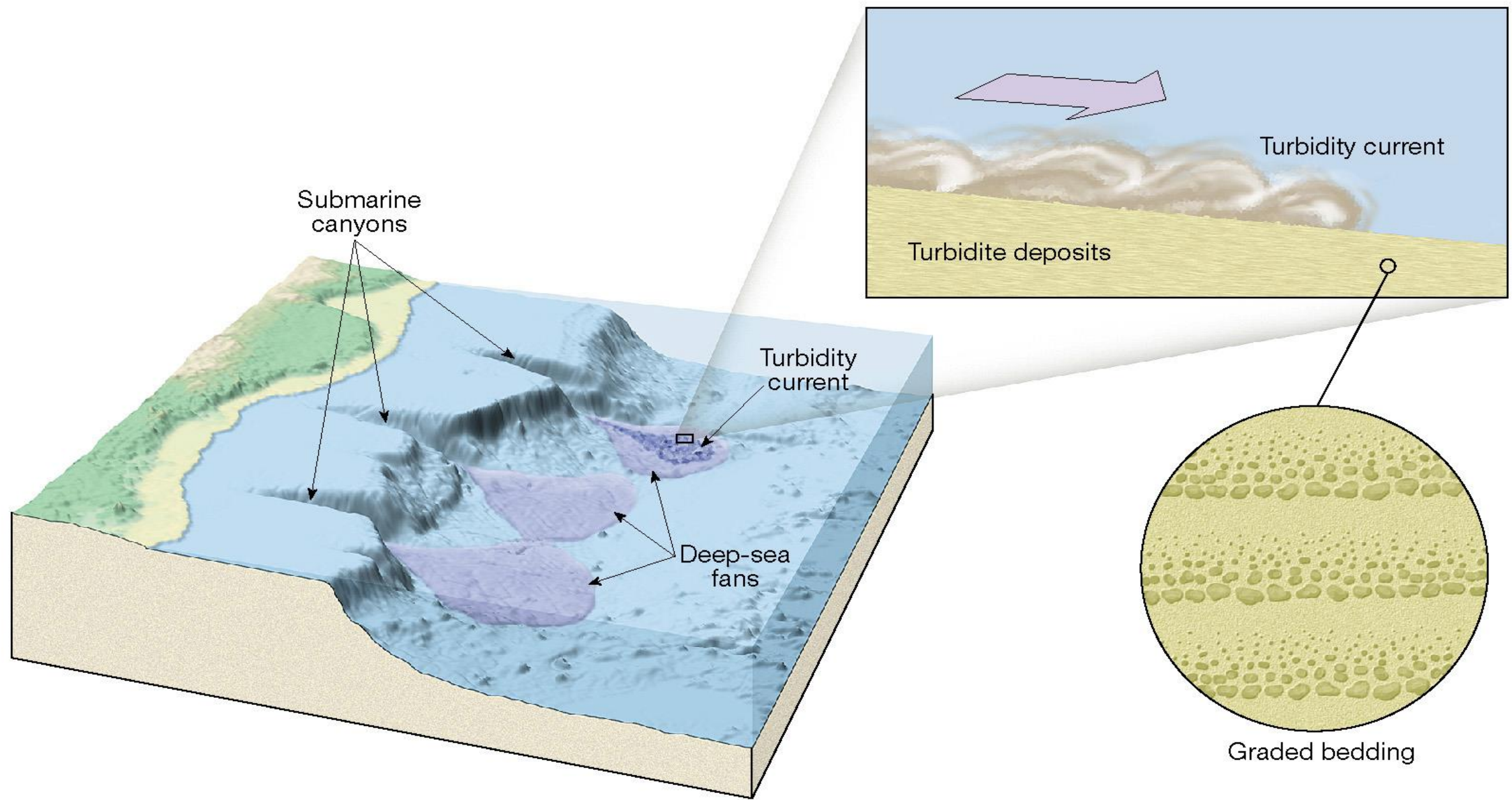
- **Found in regions where trenches are absent**
- **Continental slope merges into a more gradual incline – the continental rise**
- **Thick accumulation of sediment**

Continental rise

- A gentle slope with a generally smooth surface, built up by the shedding of sediments from the continental block, and located between the continental slope and the abyssal plain.



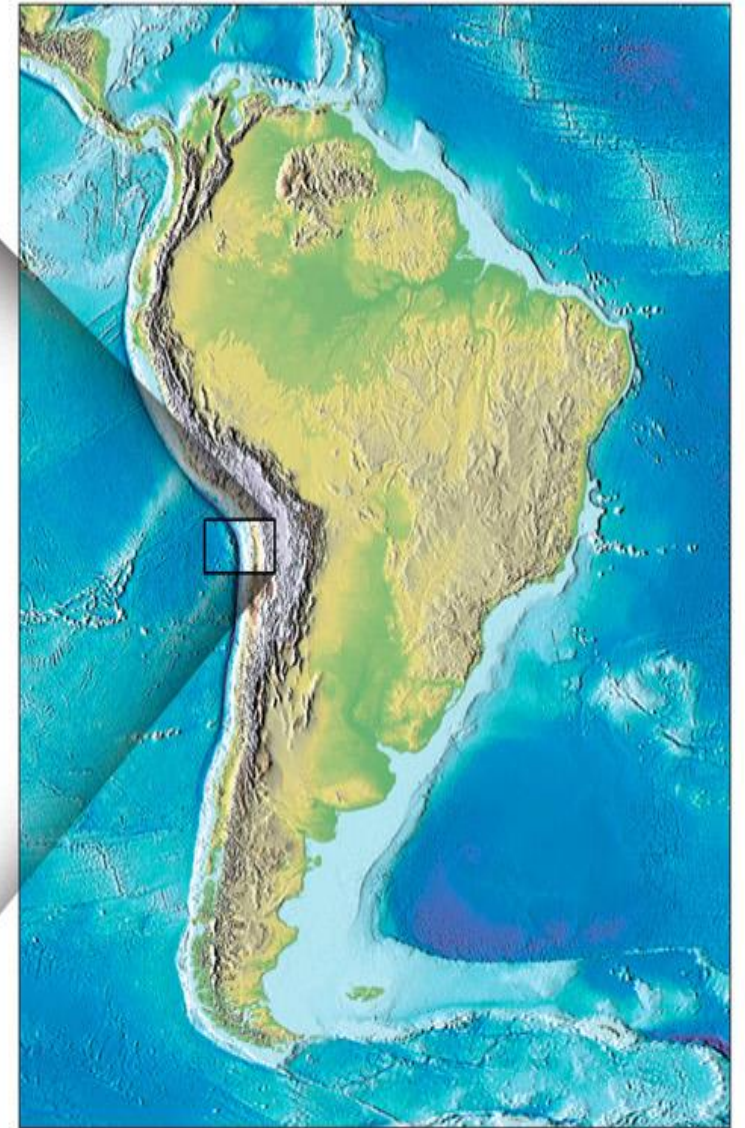
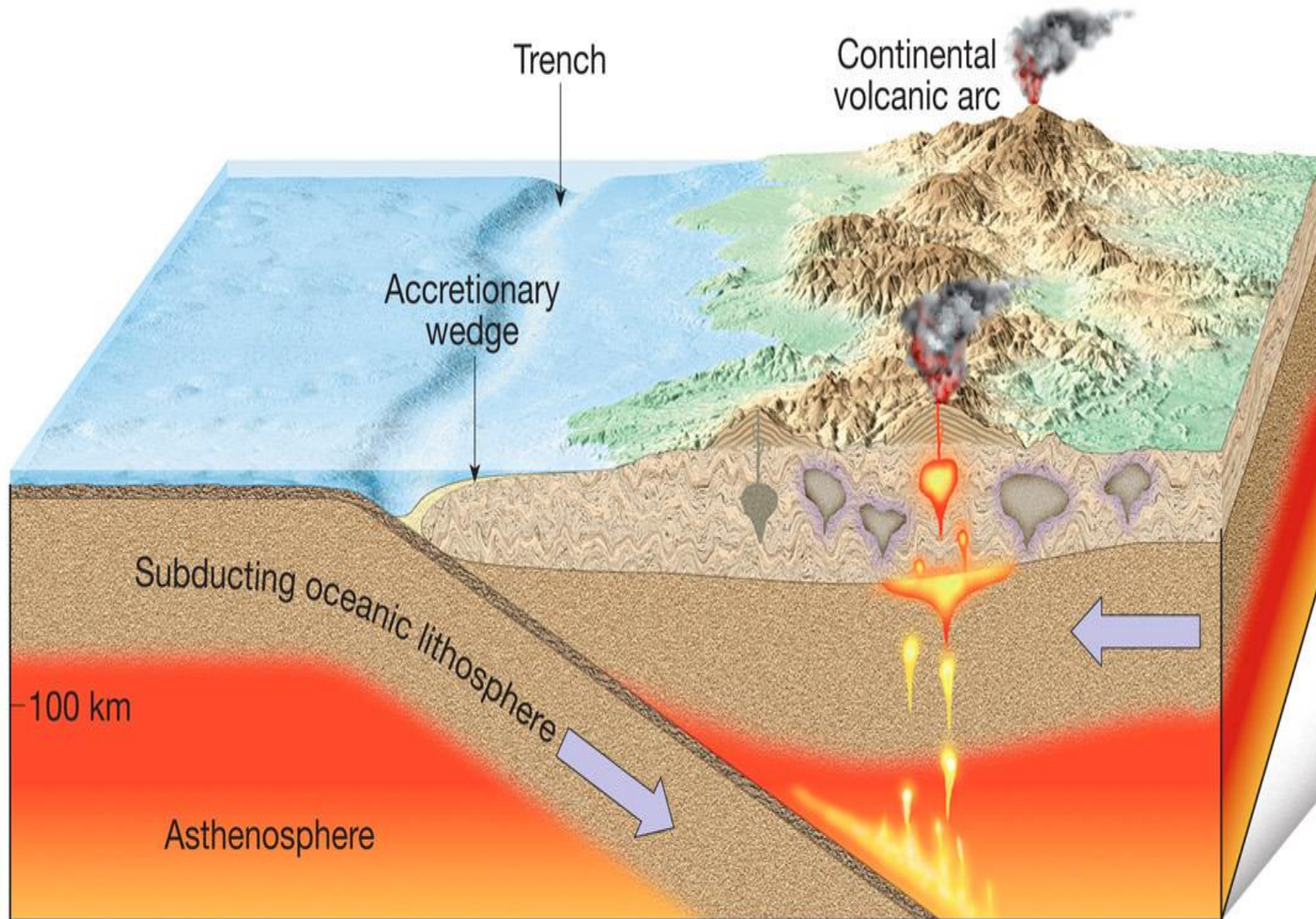
Turbidity currents



Active continental margins

- **Continental slope descends abruptly into a deep-ocean trench**
- **Located primarily around the Pacific Ocean**
- **Accumulations of deformed sediment and scraps of ocean crust form accretionary wedges**
- **Some subduction zones have little or no accumulation of sediments (narrow beaches)**

An active continental margin



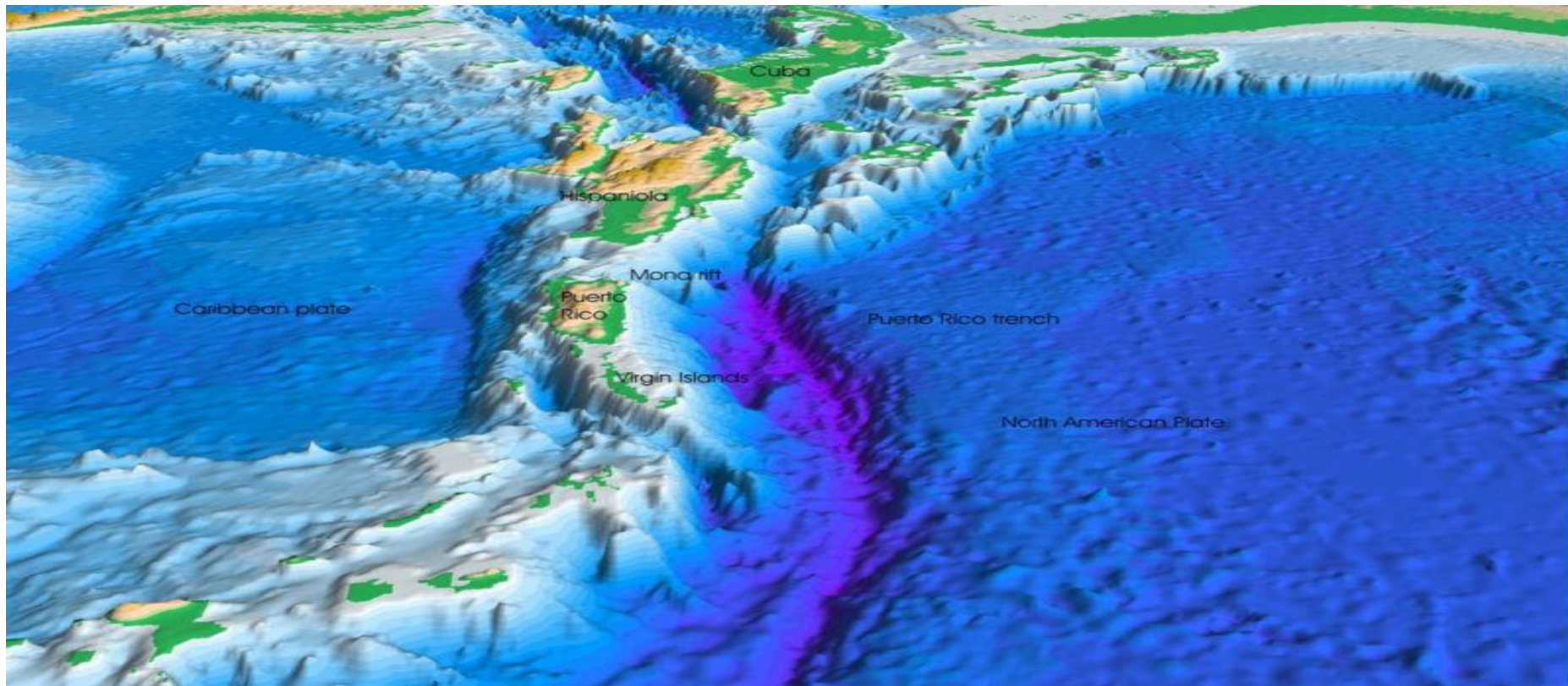
Active continental margins

❖ Deep-ocean trenches

- **Long, relatively narrow features**
- **Deepest parts of ocean**
- **Most are located in the Pacific Ocean**
- **Sites where moving lithospheric plates plunge into the mantle**
- **Associated with volcanic activity**
 - **Volcanic islands arcs (Japan)**
 - **Continental volcanic arcs (Andes, Cascades mts)**

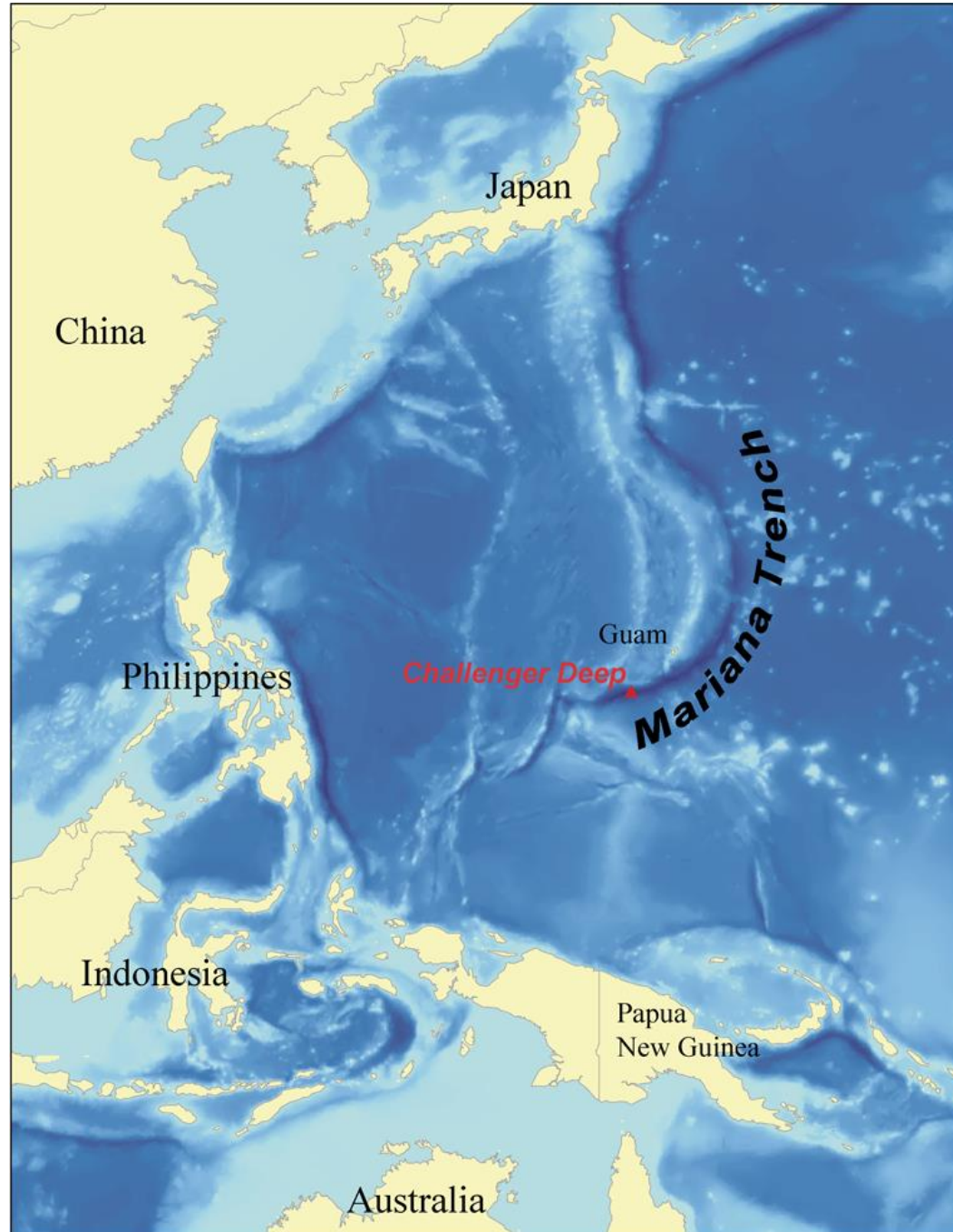
Trench

- The oceanic trenches are hemispheric-scale (one hemisphere to another) long but narrow topographic depressions of the sea floor. They are also the deepest parts of the ocean floor.



Mariana Trench

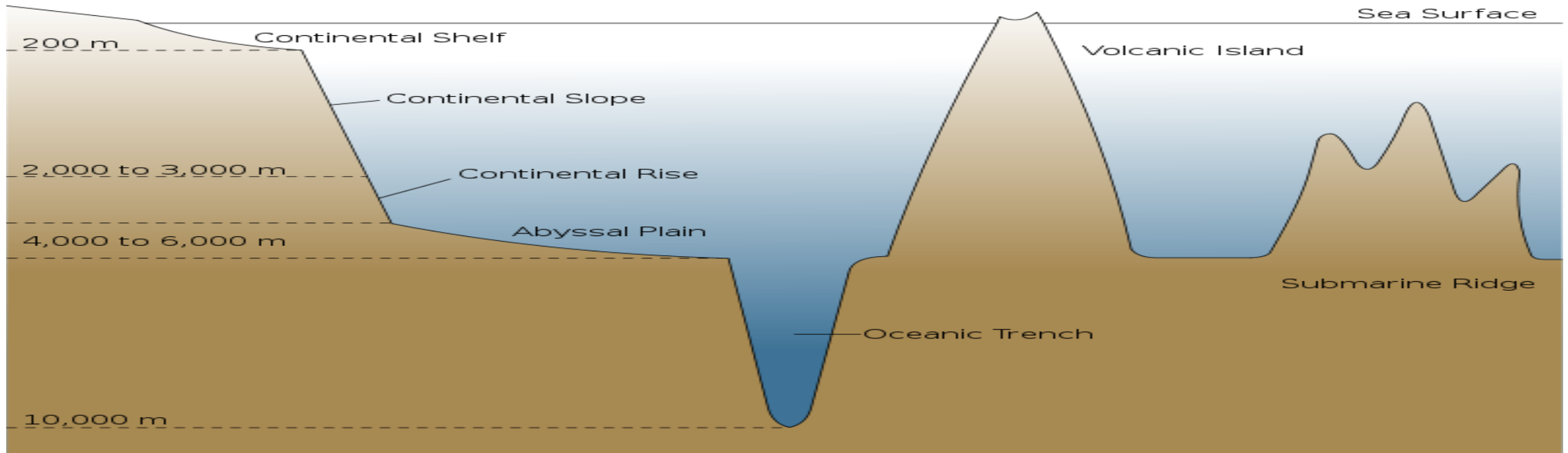
- Is the deepest part of the world's oceans, and the deepest location on the surface of the Earth's crust. It has a maximum depth of 10,911 meters, or **11 kilometers**.



II - Ocean basin floor

❖ Abyssal plains

- Likely the most level places on Earth
- Sites of thick accumulations of sediment
- **Abyssal plains are flat or very gently sloping areas of the deep ocean basin floor.**
Found in all oceans
- They generally lie between the foot of a continental rise and a mid-oceanic ridge



Ocean basin floor

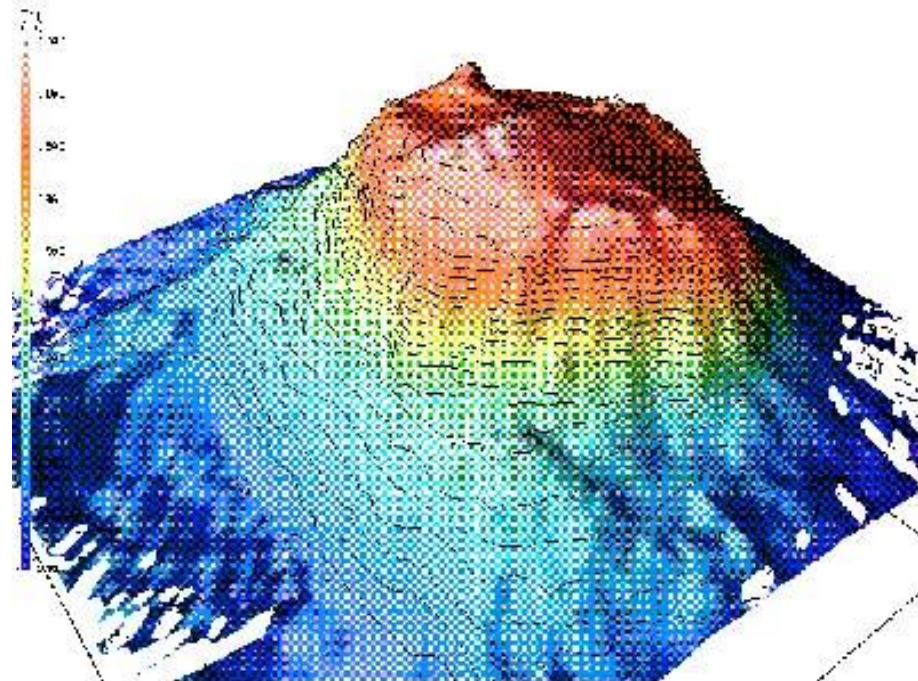
❖ Seamounds and guyots

❖ **A seamount is a mountain rising from the ocean seafloor that does not reach to the water's surface (sea level), and thus is not an island. These are typically formed from extinct volcanoes, that rise abruptly.**

- May emerge as an island

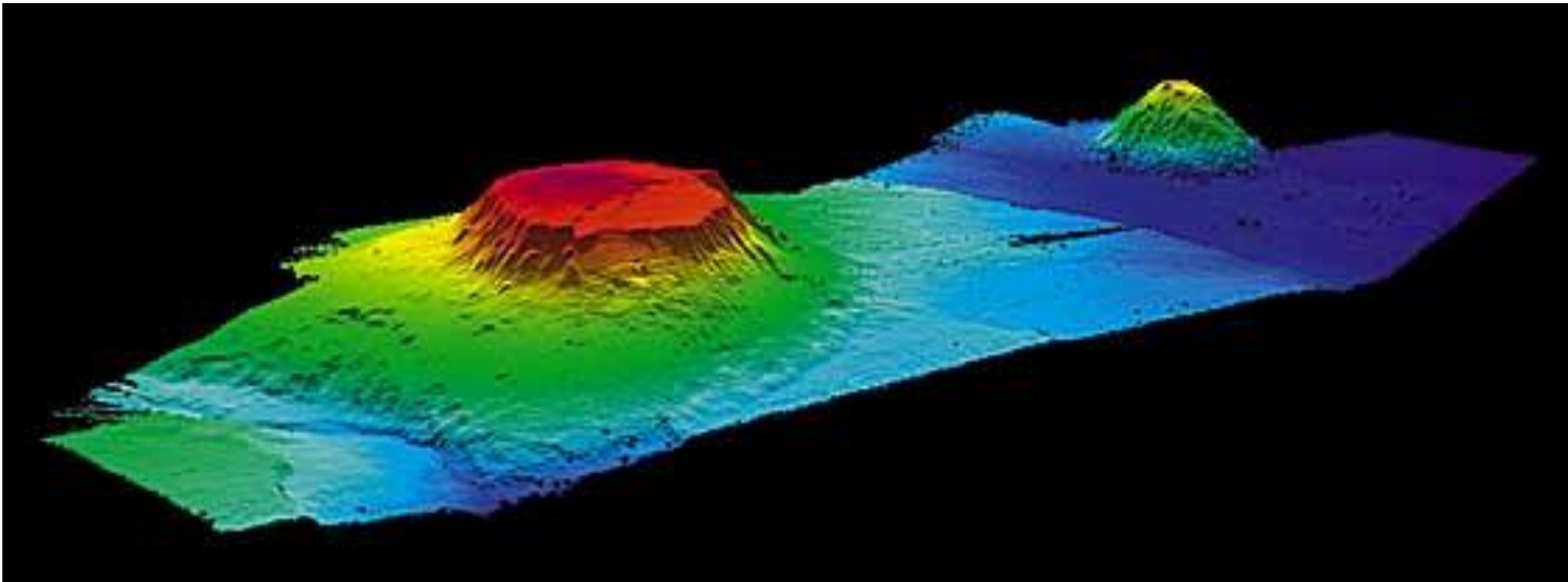
❖ May sink and form flat-topped seamounds called **guyots** or **tablemounts**

- Isolated volcanic peaks
- Many form near
- oceanic ridges



Guyot

- A **guyot** also known as a **tablemount**, is a flat-topped seamount. Their flatness is due to erosion by waves, winds, and atmospheric processes.

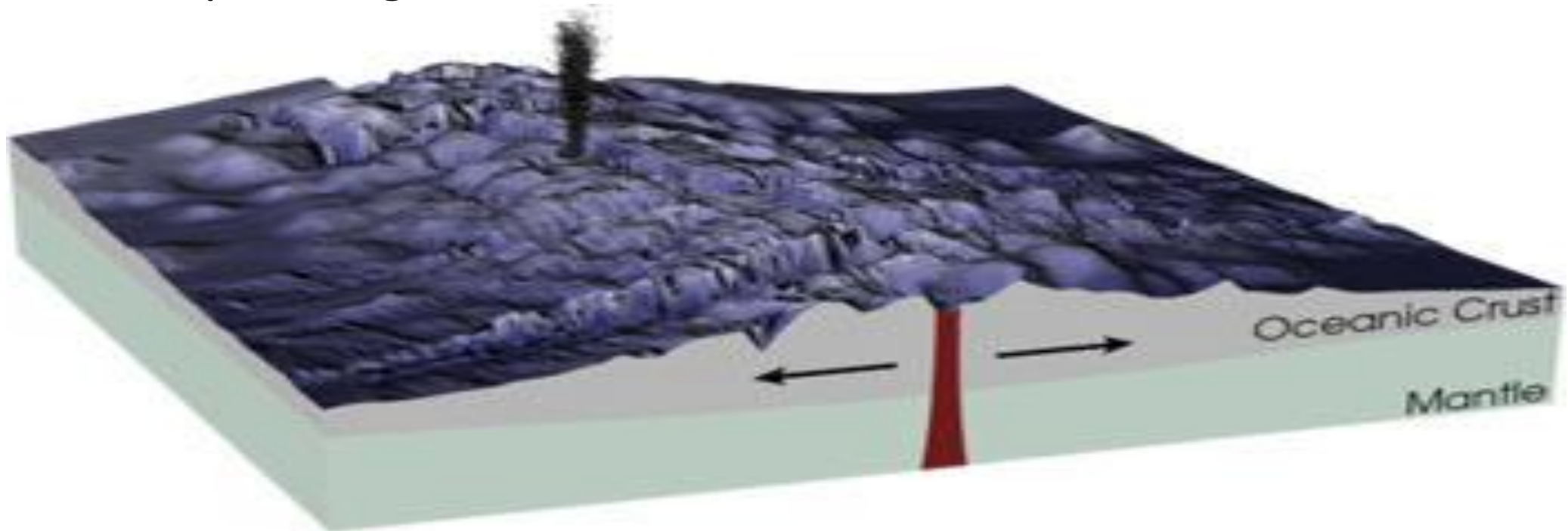


III - Mid-ocean ridge

- **An elevated position**
- **Extensive faulting**
- **Numerous volcanic structures that have developed on newly formed crust**
 - **ridge system is the longest topographic feature on Earth's surface**
 - **Over 70,000 kilometers (43,000 miles) in length**
 - **Twenty-three percent of Earth's surface**
 - **Winds through all major oceans**
 - **Along the axis of some segments are deep down faulted structures called *rift valleys***

Mid-Ocean ridge

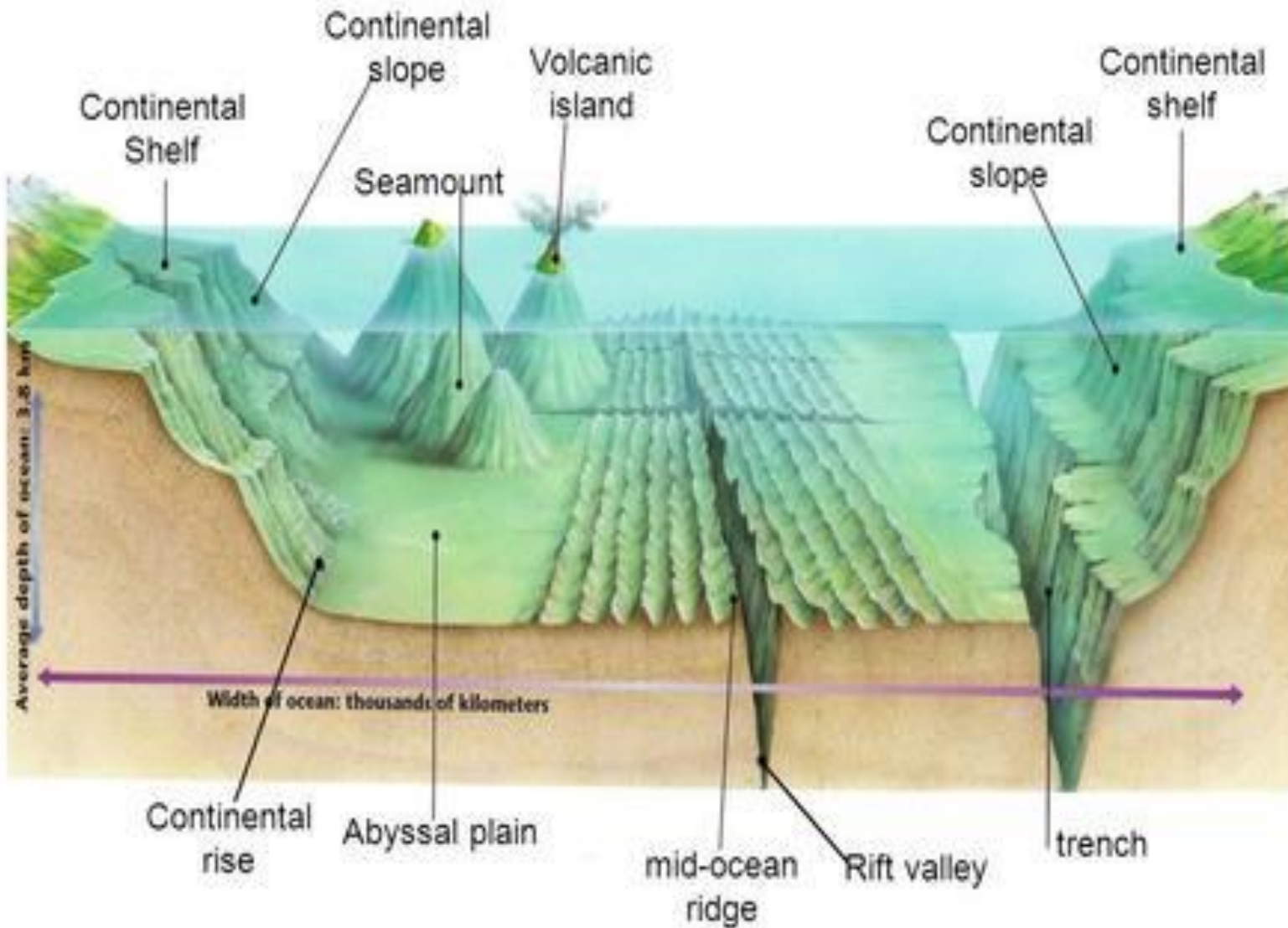
- A **mid-ocean ridge** is an underwater mountain range, typically having a valley known as a rift running along its spine, formed by plate tectonics. It is usually an **oceanic spreading center**, which is responsible for seafloor spreading.



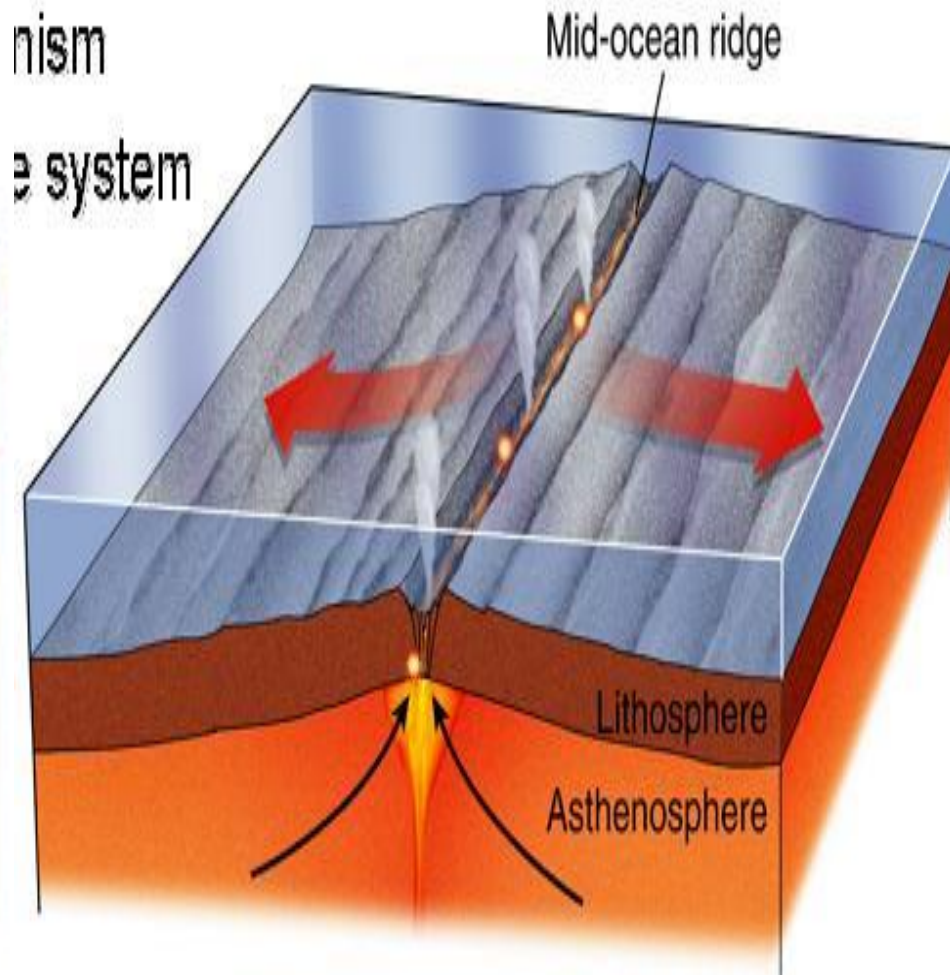
Mid-ocean ridge

- **Consist of layer upon layer of basaltic rocks that have been faulted and uplifted**
- **Mid-Atlantic Ridge has been studied more thoroughly than any other ridge system**
- **A long mountain range on the ocean floor, extending almost continuously through the North and South Atlantic Oceans, the Indian Ocean, and the South Pacific Ocean.**
- **A deep rift valley is located at its center, from which magma flows and forms new oceanic crust.**
- **As the magma cools and hardens it becomes part of the mountain range.**
- **The mid-ocean ridge is approximately 1,500 km (930 mi) wide, 1 to 3 km (0.62 to 1.86 mi) high, and over 84,000 km (52, 080 mi) long.**

The Ocean Floor



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e system

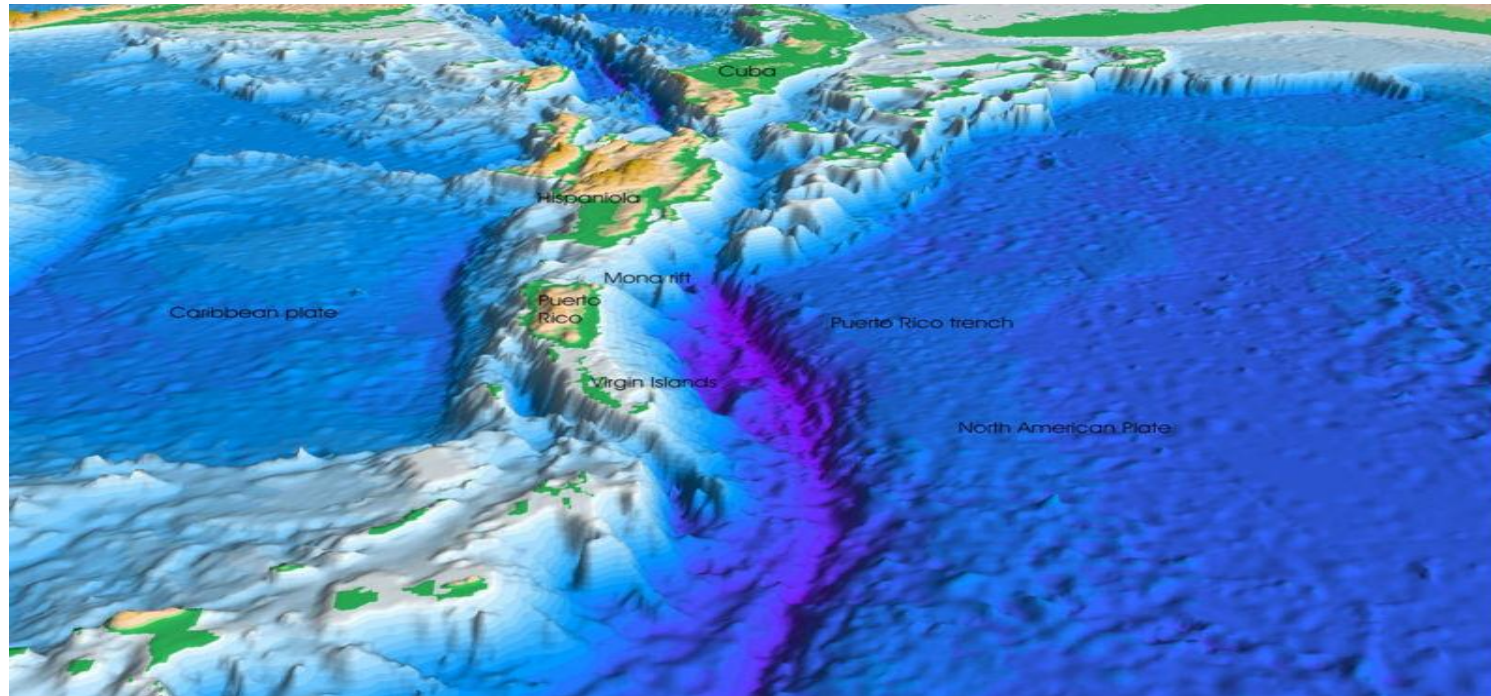


(a) Divergent boundary

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Trench

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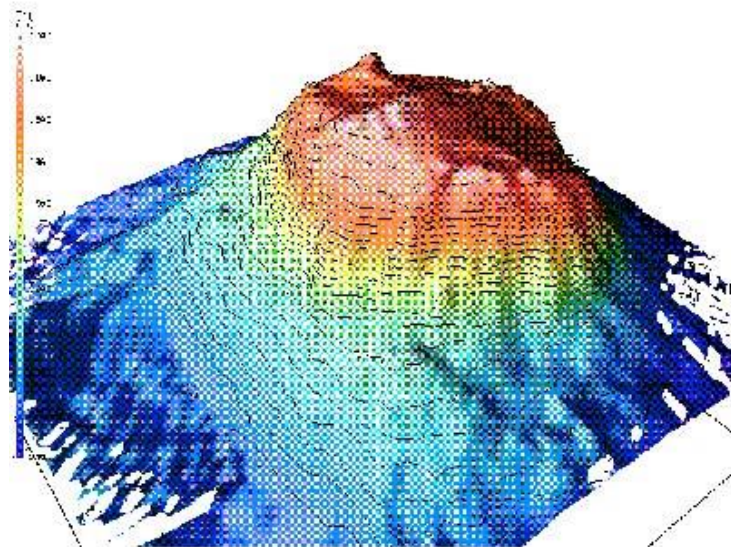
Mariana Trench

- Is the deepest part of the world's oceans, and the deepest location on the surface of the Earth's crust. It has a maximum depth of about 10,911 meters, or 11 kilometers.



Sea Mount

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Oceanic Island

- One type of oceanic island is found in a volcanic island arc. These islands arise from volcanoes where the subduction of one plate under another is occurring.



Atoll

- An **atoll** is an island of coral that encircles a lagoon partially or completely.



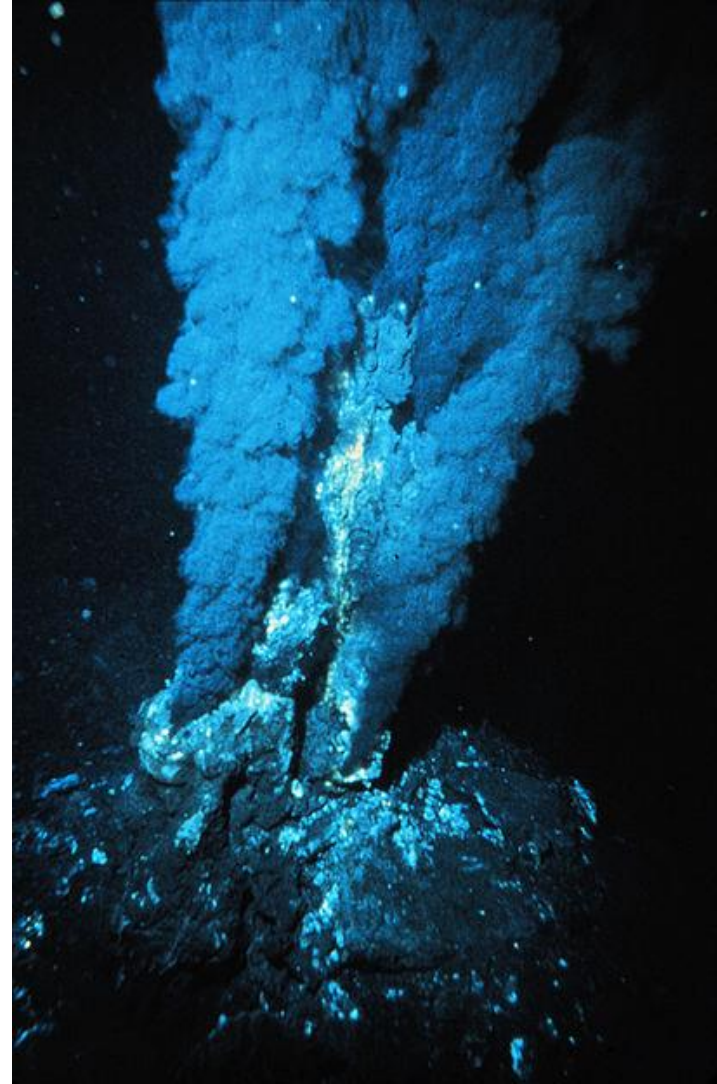
Volcanic fissure

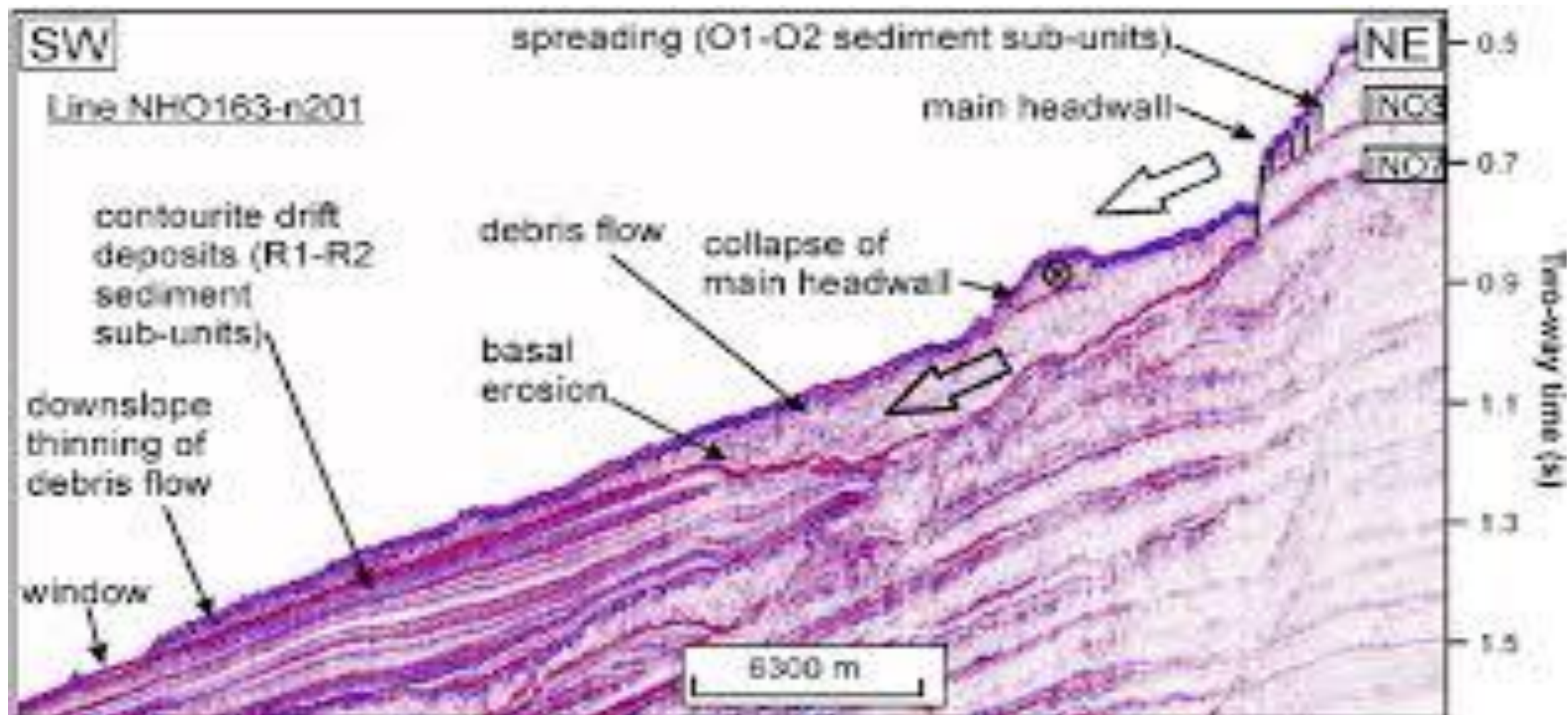
- A linear volcanic vent through which lava erupts, usually without any explosive activity. The vent is usually a few meters wide and may be many kilometers long



Hydrothermal Vent

- A **hydrothermal vent** is a fissure in a planet's surface from which geothermal heated water issues. Hydrothermal vents are commonly found near volcanically active places, areas where tectonic plates are moving apart, ocean basins, and hotspots.





WEATHERING

..... is the breakdown of rocks.

