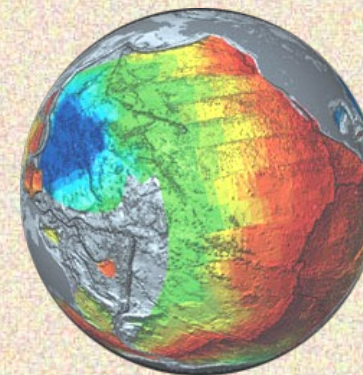
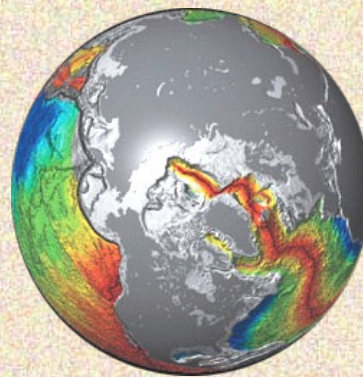
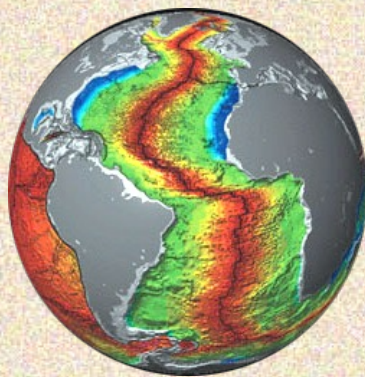




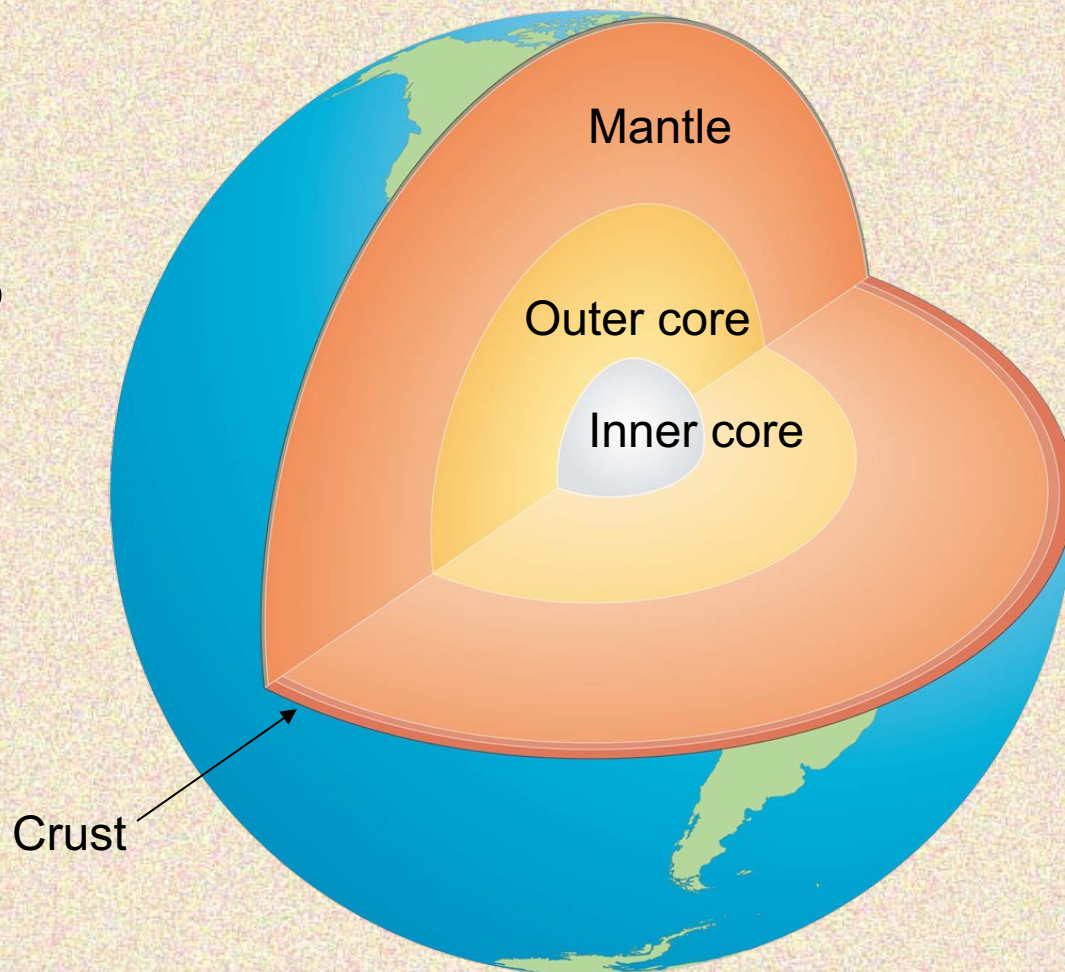
The Structure of the Earth and Plate Tectonics





Structure of the Earth

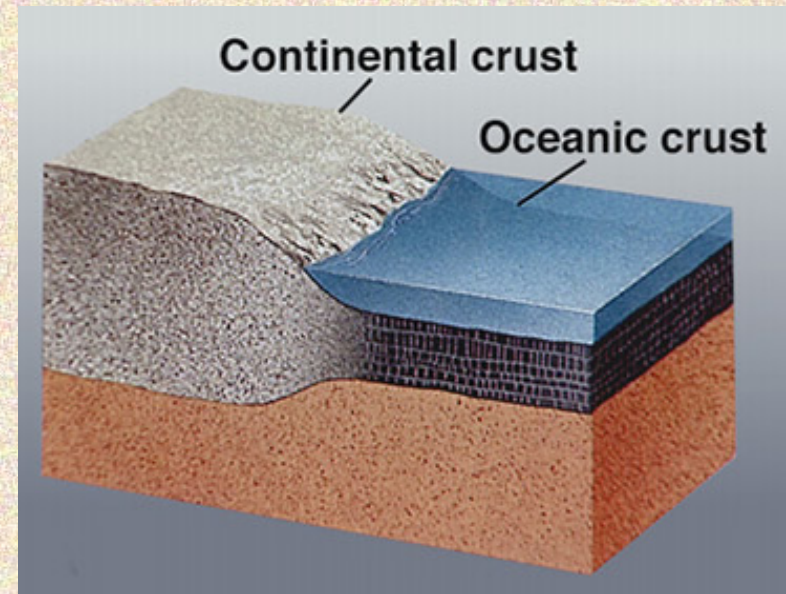
- The Earth is made up of 3 main layers:
 - Core
 - Mantle
 - Crust





The Crust

- This is where we live!
- The Earth's crust is made of:



Continental Crust

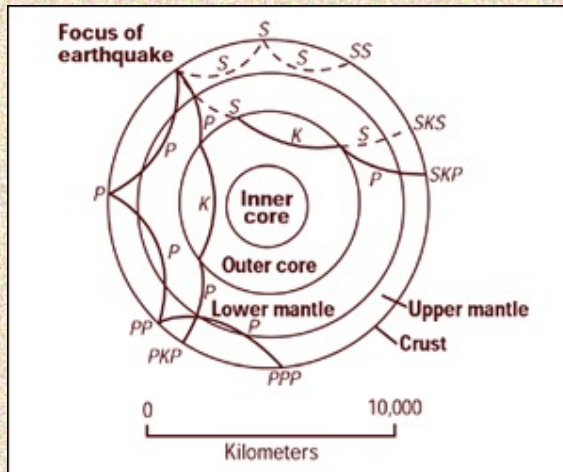
- thick (10-70km)
- buoyant (less dense than oceanic crust)
- mostly old

Oceanic Crust

- thin (~7 km)
- dense (sinks under continental crust)
- young

How do we know what the Earth is made of?

- Geophysical surveys: seismic, gravity, magnetics, electrical,
- Acquisition: land, air, sea and satellite
 - Geological surveys: fieldwork, boreholes, mines

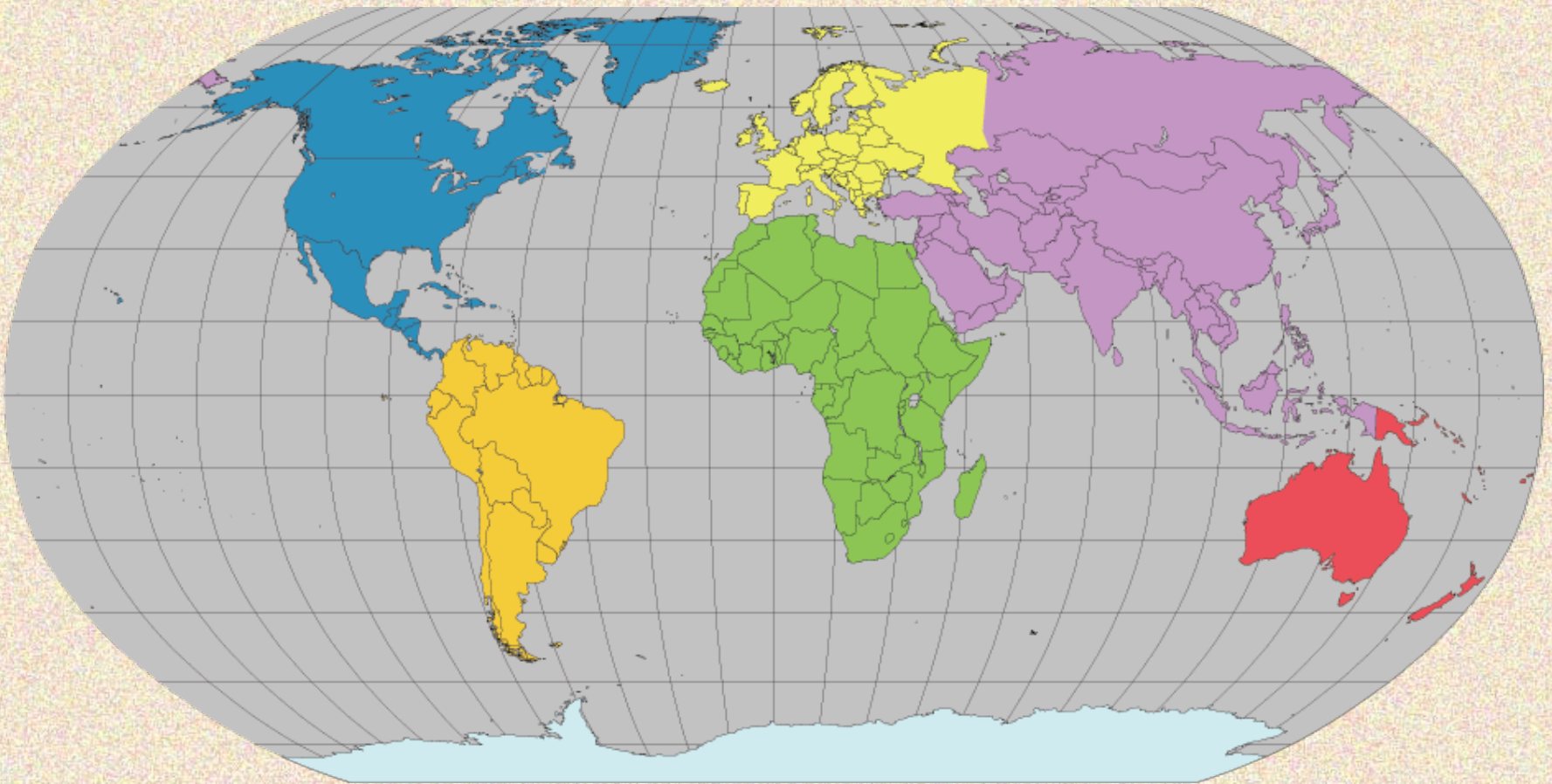




What is Plate Tectonics?



- If you look at a map of the world, you may notice that some of the continents could fit together like pieces of a puzzle.



9.1 Continental Drift

An Idea Before Its Time

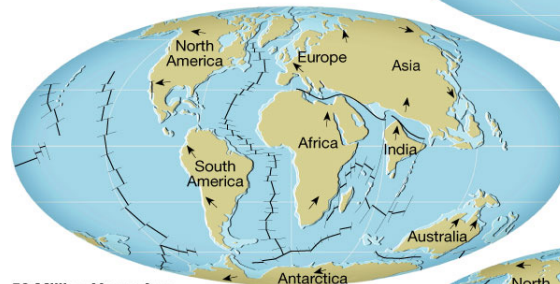
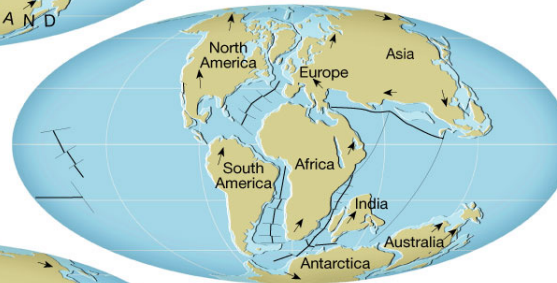
- ◆ **continental drift** hypothesis stated that the continents had once been joined to form a single supercontinent.
- Continental drift proposed that the supercontinent, **Pangaea**, began to break apart 200 million years ago and form the present landmasses.

Breakup of Pangaea



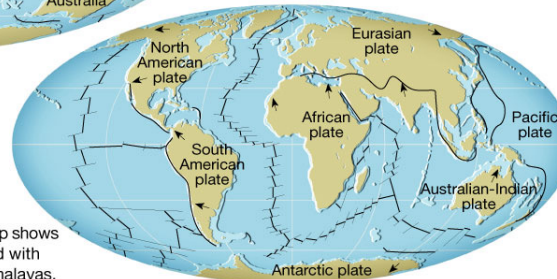
250 Million Years Ago
Pangaea consisted of all the major continents.

200 Million Years Ago The rifting that eventually resulted in the Atlantic Ocean occurred over an extended period of time. The first rift developed between North America and Africa.



100 Million Years Ago
Continued rifting of the southern landmasses sent India on a northward journey.

50 Million Years Ago
Australia began to separate from Antarctica.



Present A modern map shows that India has collided with Asia, creating the Himalayas.

9.1 Continental Drift

An Idea Before Its Time

◆ Evidence

- Rock Types and Structures
 - Rock evidence for continental drift exists in the form of several mountain belts that end at one coastline, only to reappear on a landmass across the ocean.
- Ancient Climates

Matching Mountain Ranges



Glacier Evidence

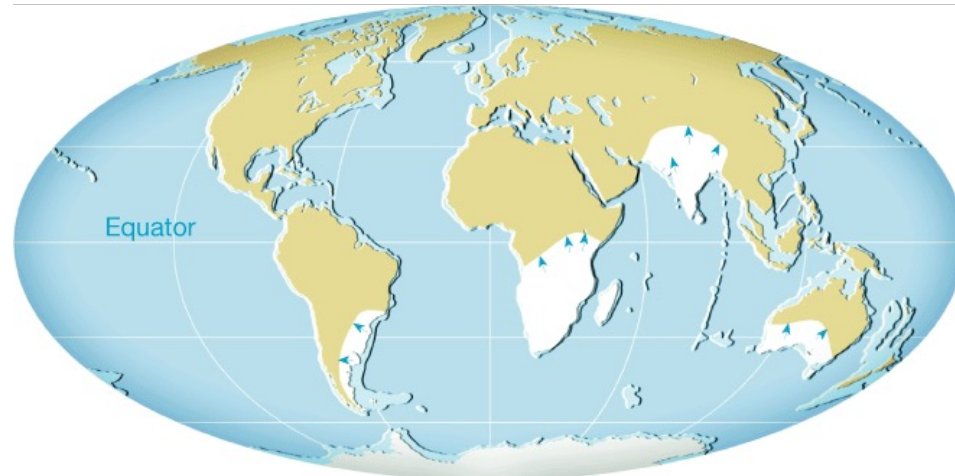


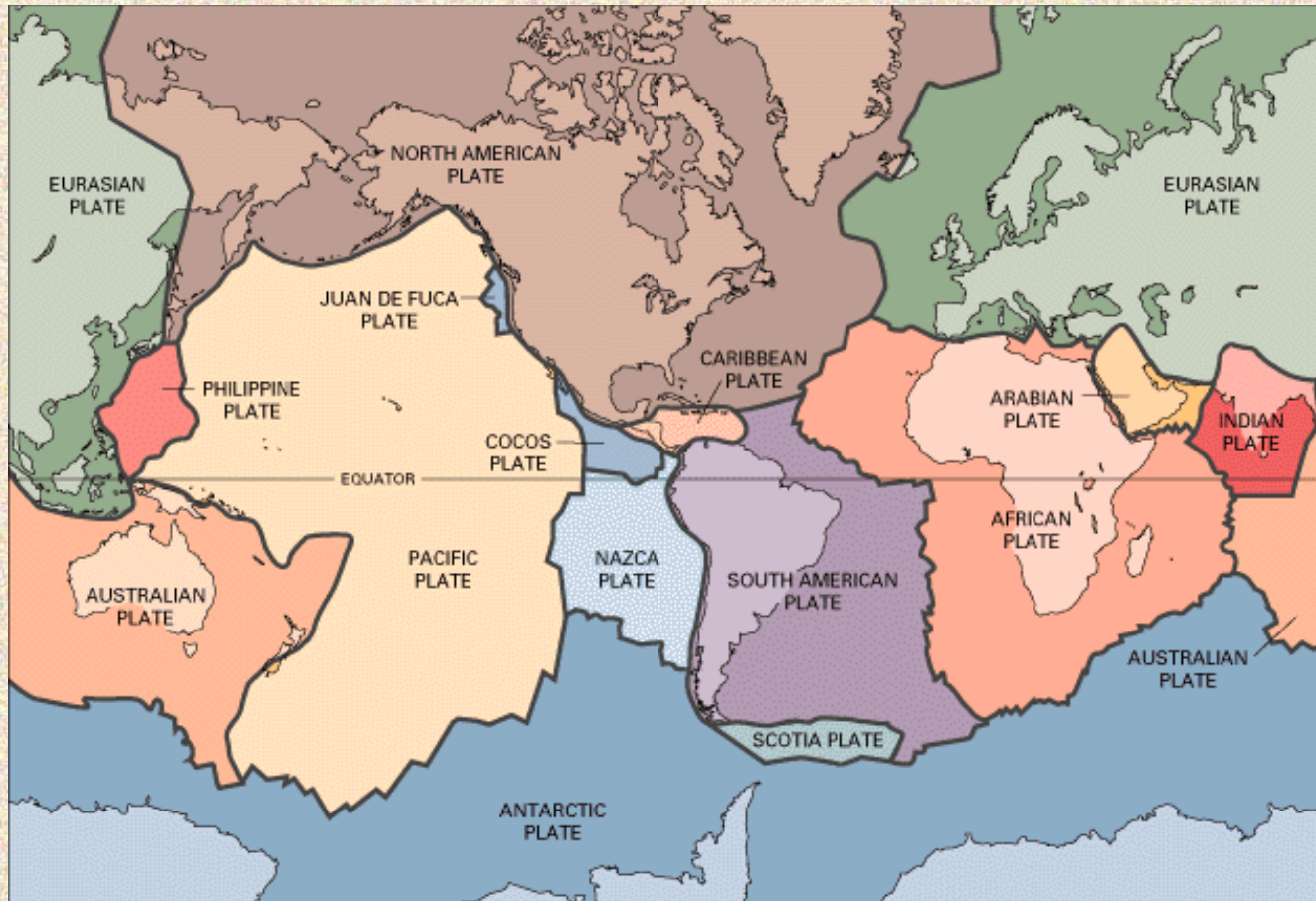


Plate Tectonics

- The Earth's crust is divided into 12 major plates which are moved in various directions.
- This plate motion causes them to collide, pull apart, or scrape against each other.
- Each type of interaction causes a characteristic set of Earth structures or "tectonic" features.
- The word, tectonic, refers to the deformation of the crust as a consequence of plate interaction.



World Plates

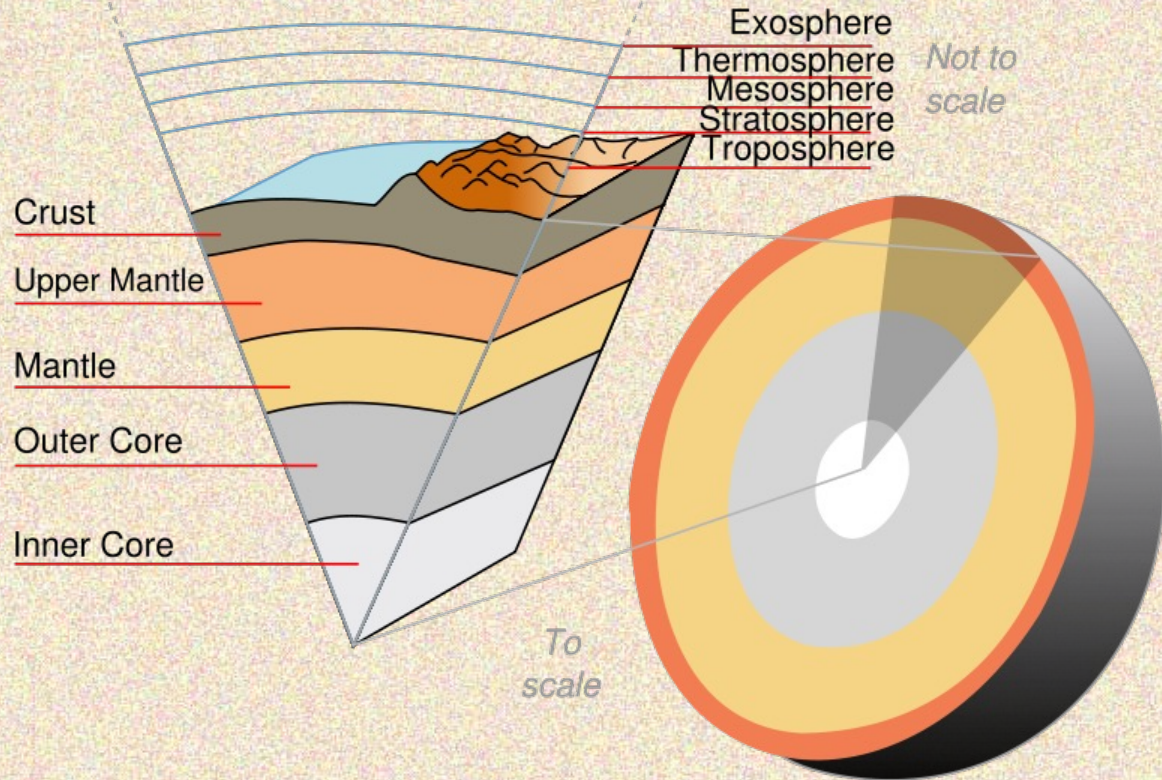




What are tectonic plates made of?

- Plates are made of rigid **lithosphere**.

The lithosphere is made up of the crust and the upper part of the mantle.





What lies beneath the tectonic plates?

- Below the lithosphere (which makes up the tectonic plates) is the asthenosphere.

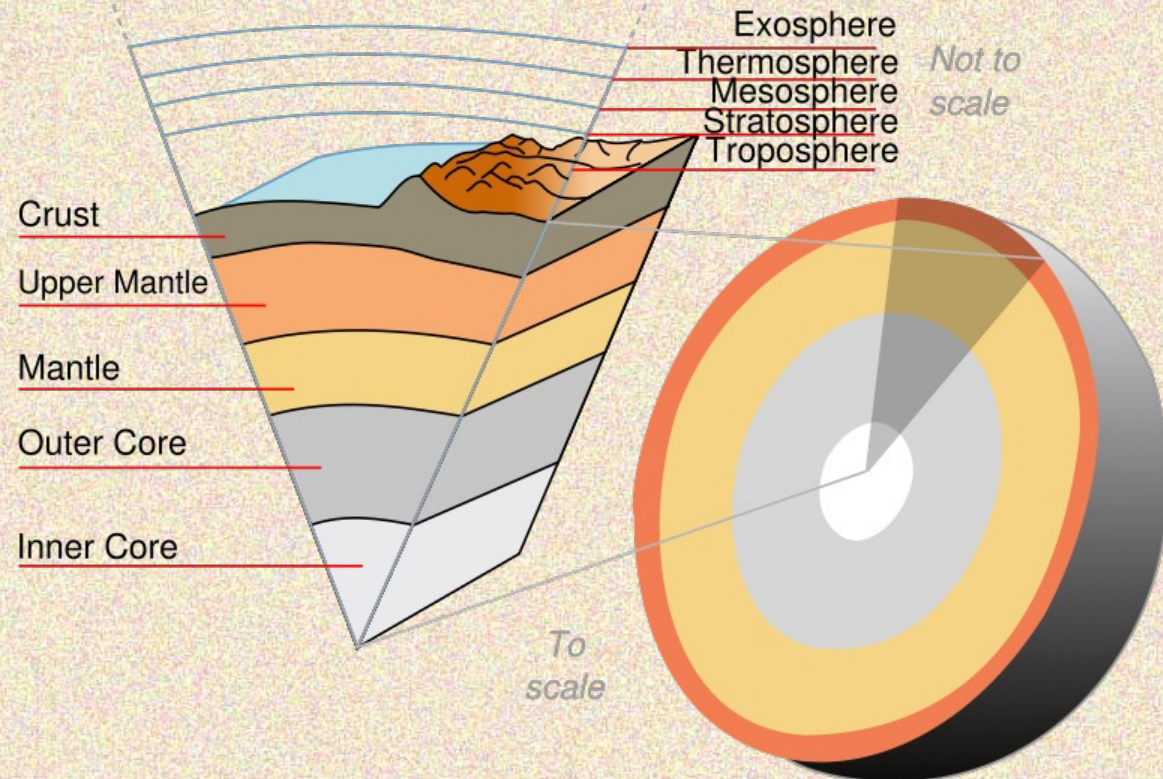
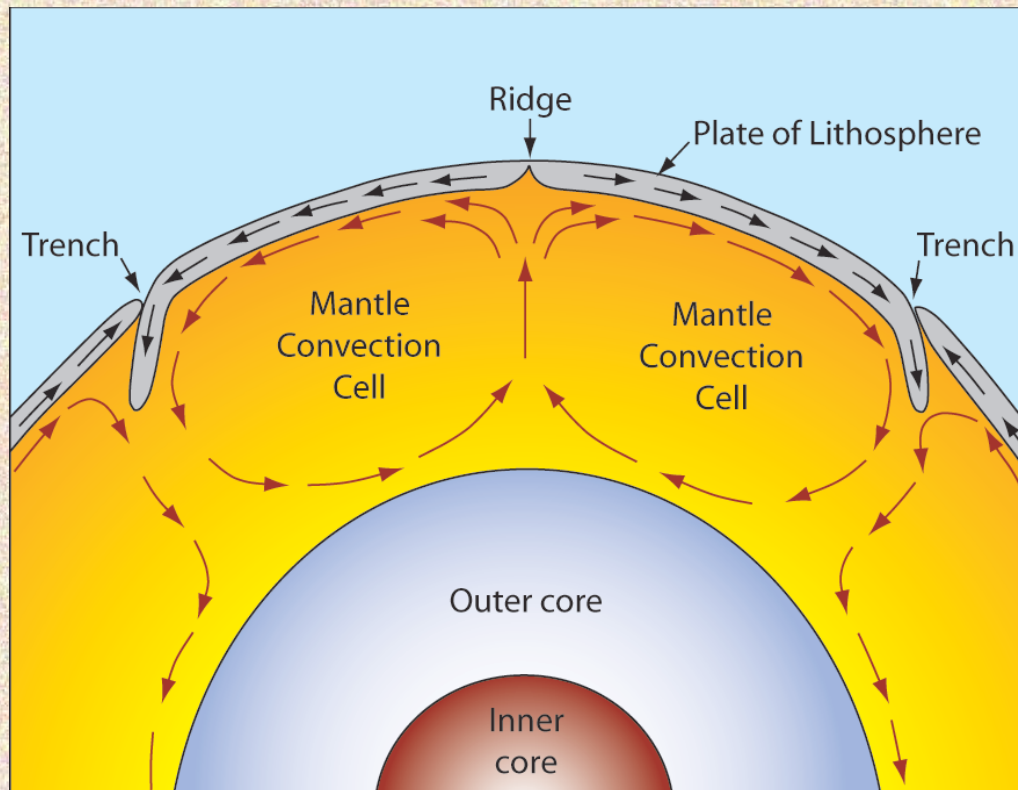




Plate Movement

- “Plates” of lithosphere are moved around by the underlying hot mantle convection cells





Practical Exercise 1

Supercontinents!

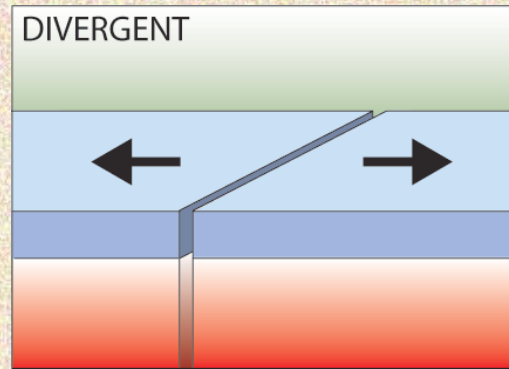


What happens at tectonic plate boundaries?

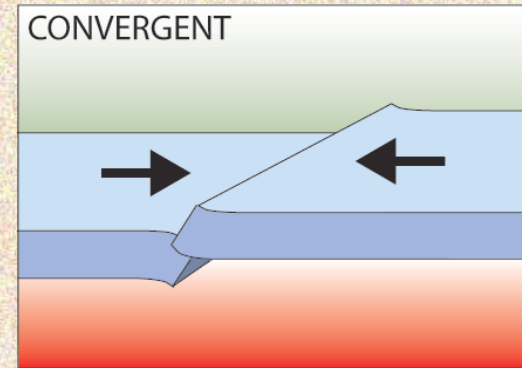


Three types of plate boundary

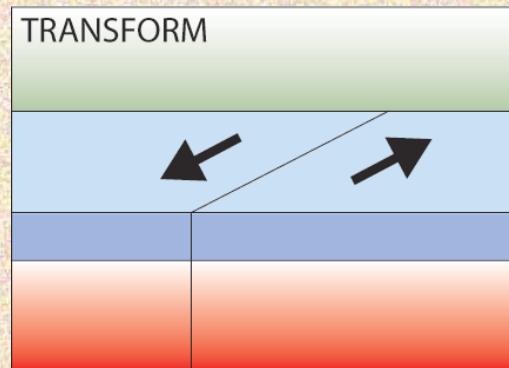
- Divergent



- Convergent

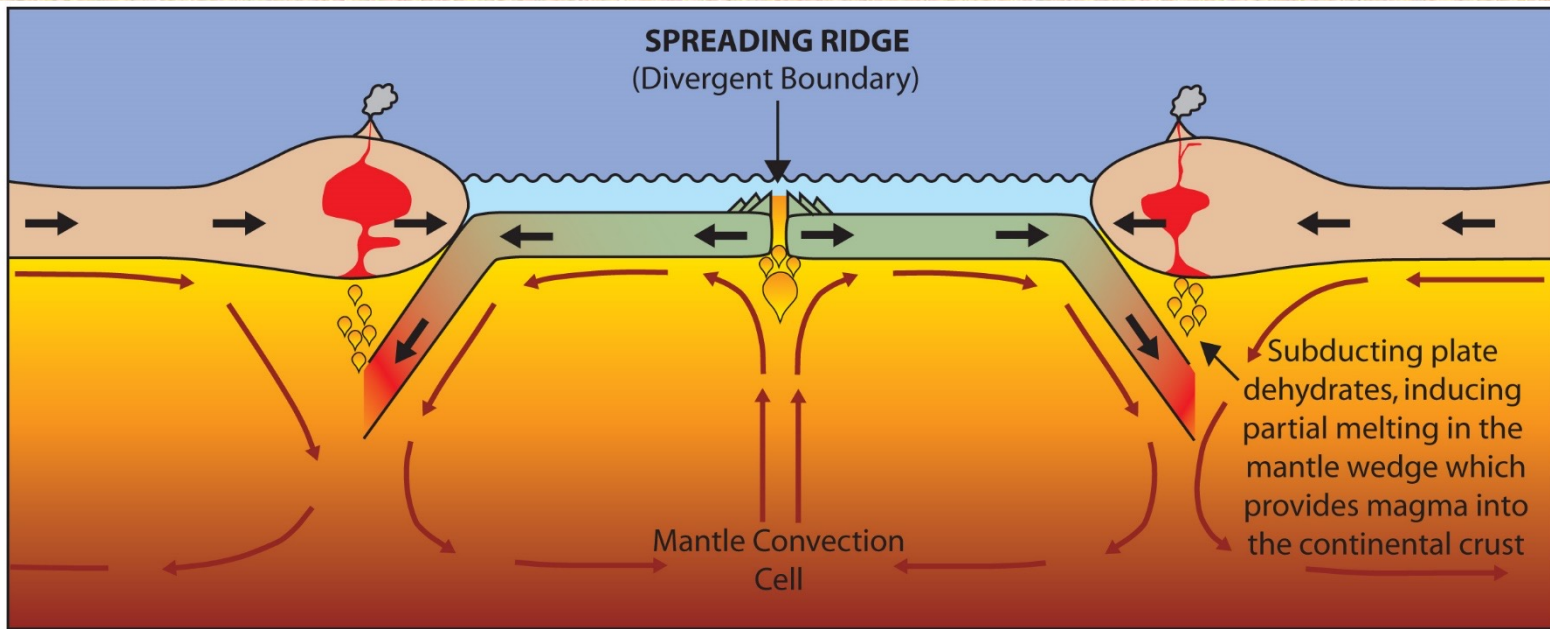


- Transform





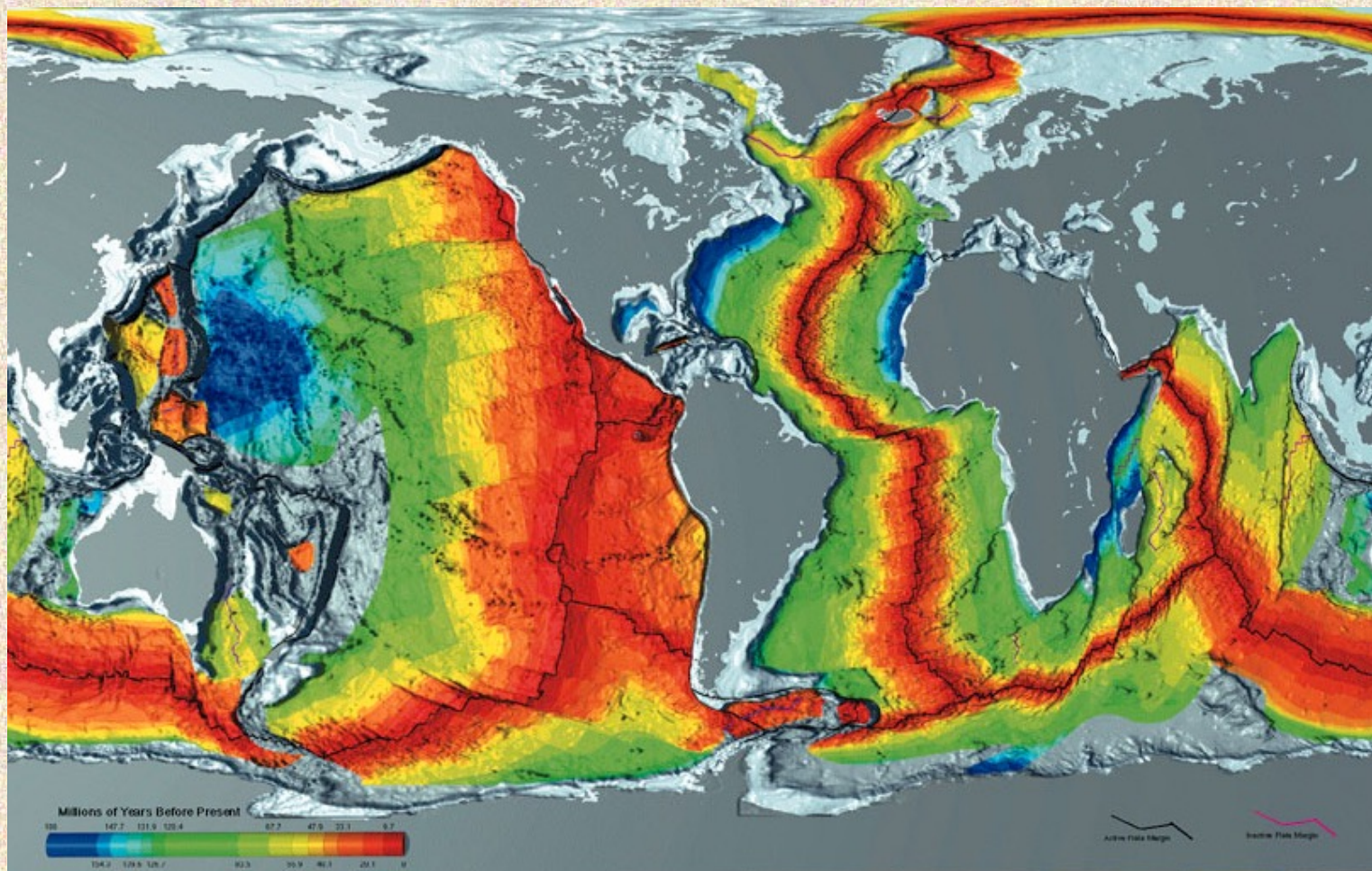
Divergent Boundaries



- Spreading ridges
 - As plates move apart new material is erupted to fill the gap



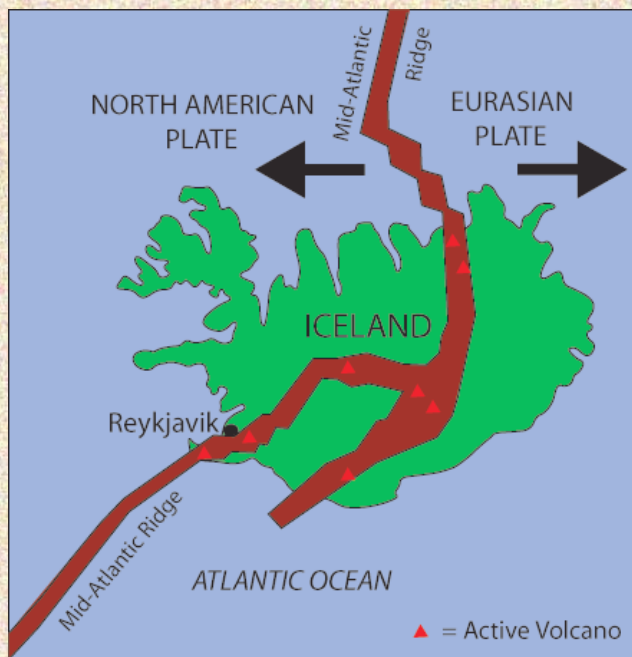
Age of Oceanic Crust





Iceland: An example of continental rifting

- Iceland has a divergent plate boundary running through its middle



East African Rift Valley





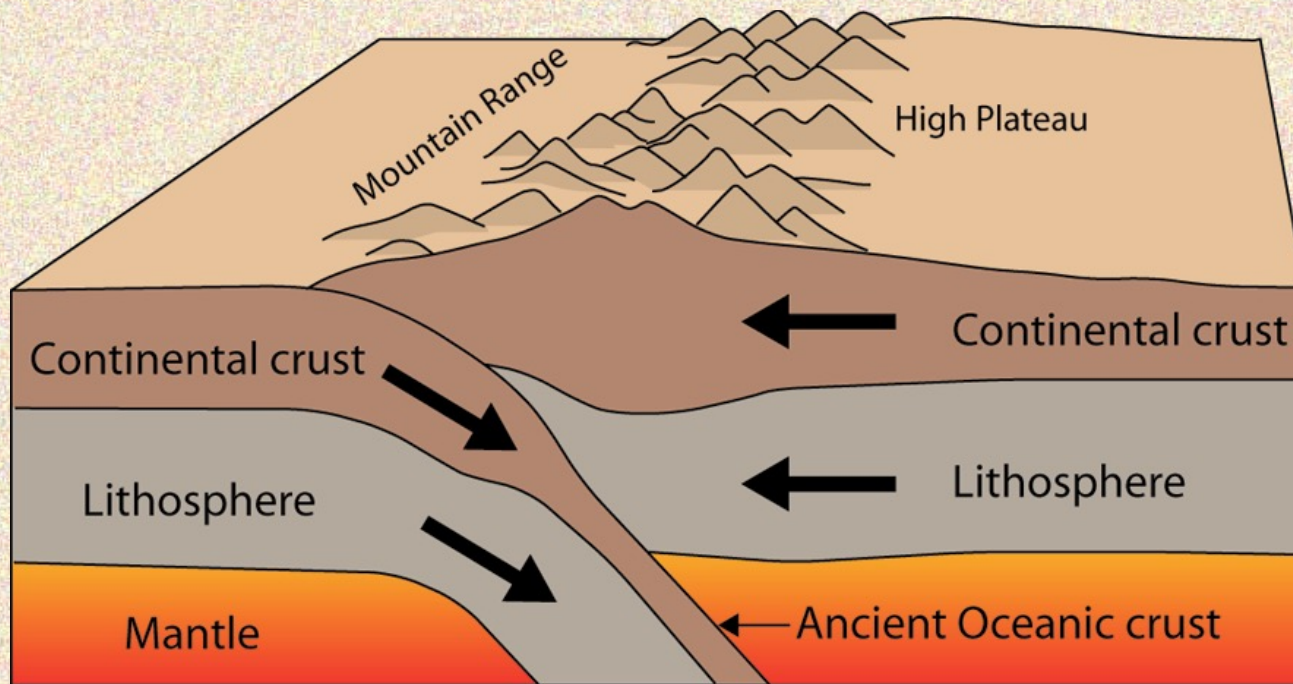
Convergent Boundaries

- There are three styles of convergent plate boundaries
 - Continent-continent collision
 - Continent-oceanic crust collision
 - Ocean-ocean collision



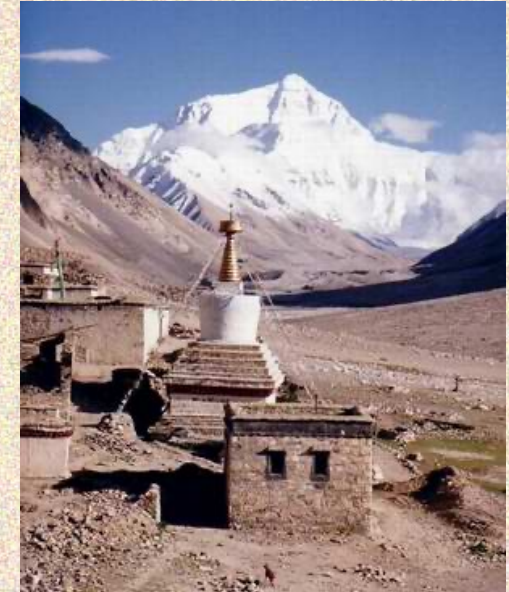
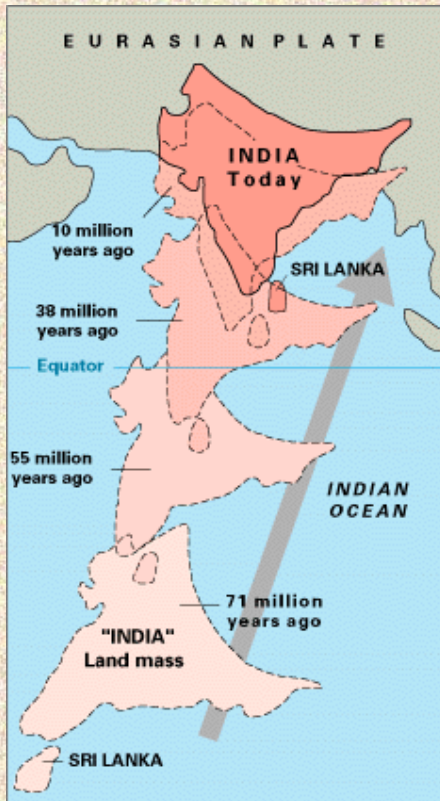
Continent-Continent Collision

- Forms mountains, e.g. European Alps, Himalayas





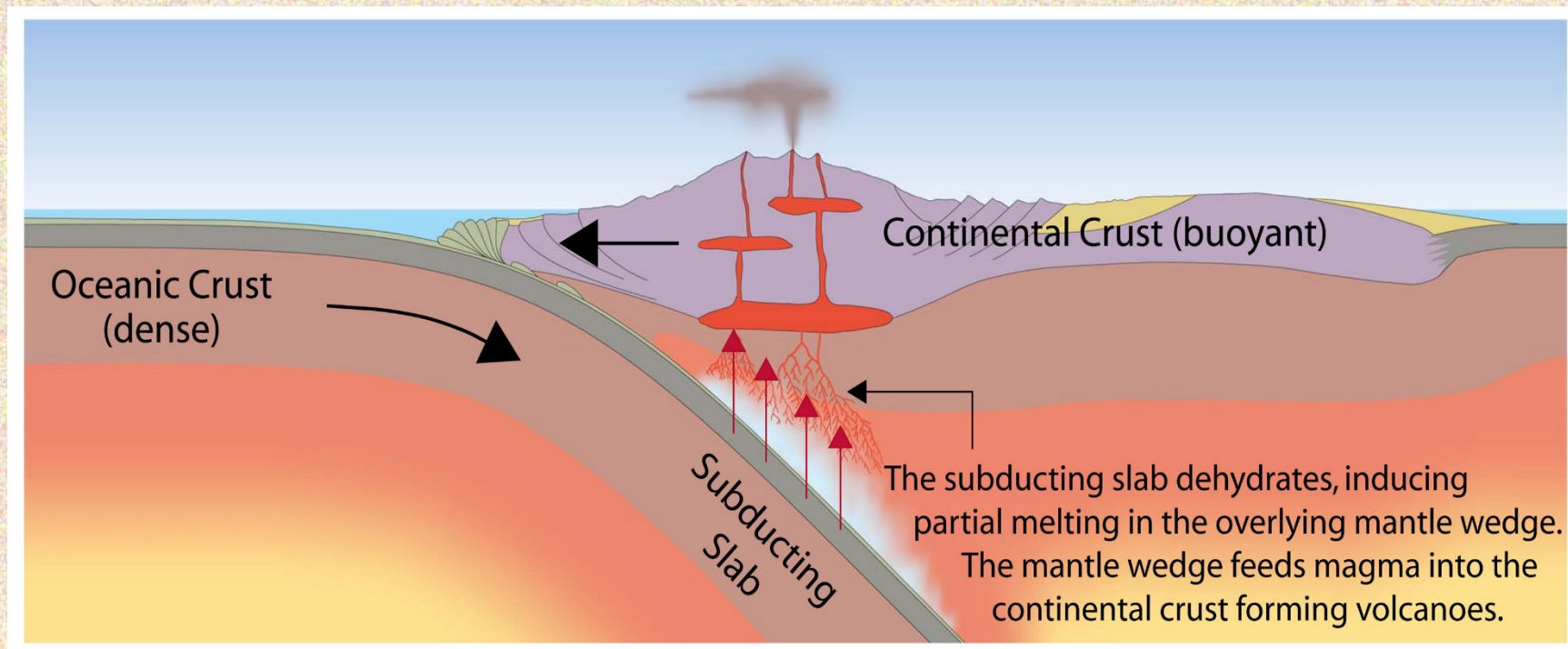
Himalayas





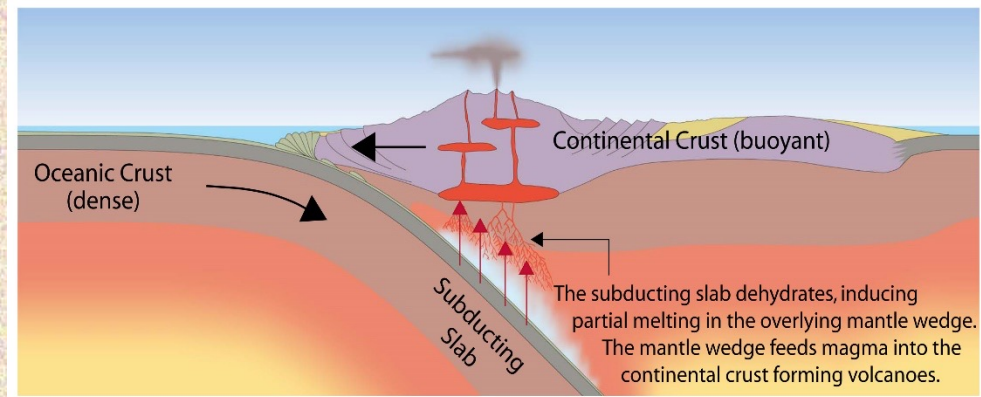
Continent-Oceanic Crust Collision

- Called SUBDUCTION





Subduction

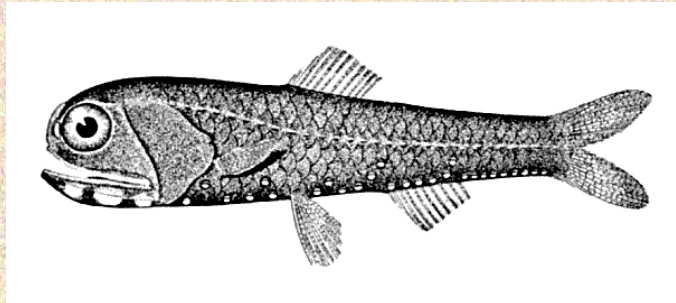
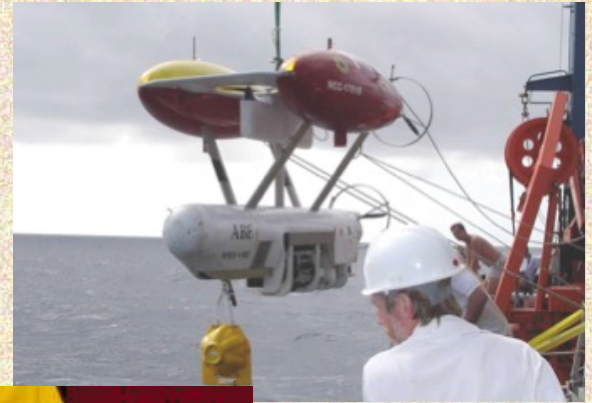
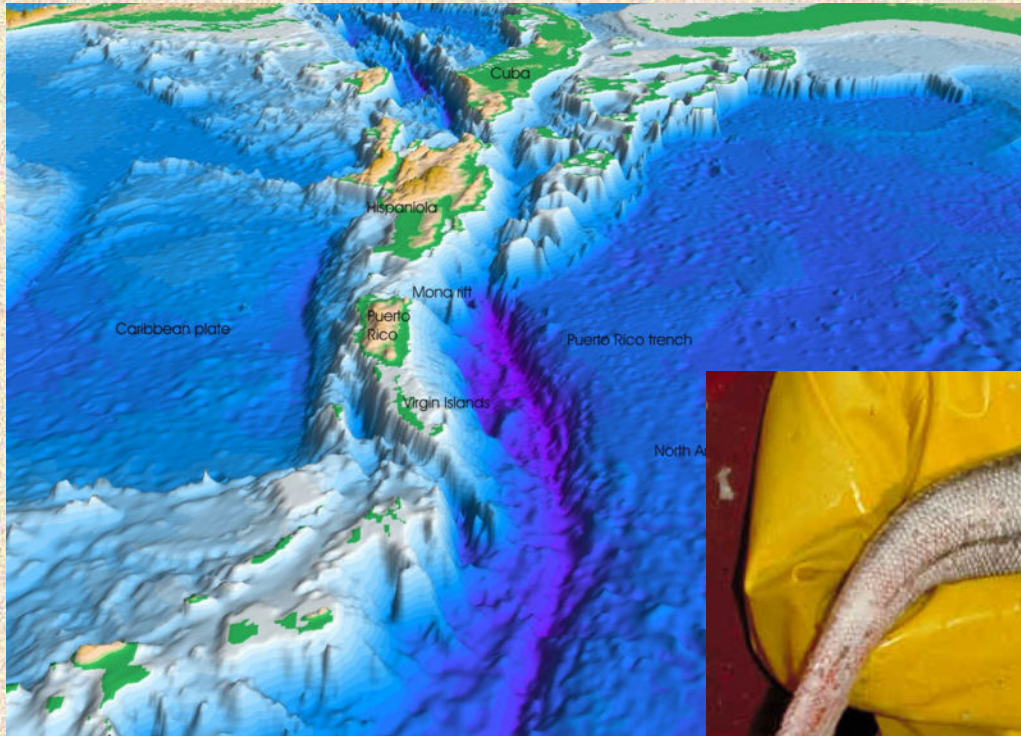


- Oceanic lithosphere subducts underneath the continental lithosphere
- Oceanic lithosphere heats and dehydrates as it subsides
- The melt rises forming volcanism
- E.g. The Andes



Ocean-Ocean Plate Collision

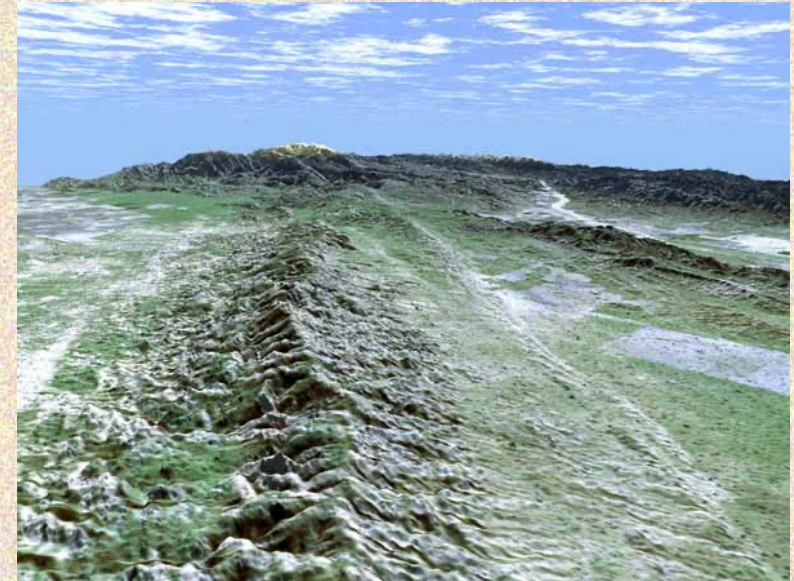
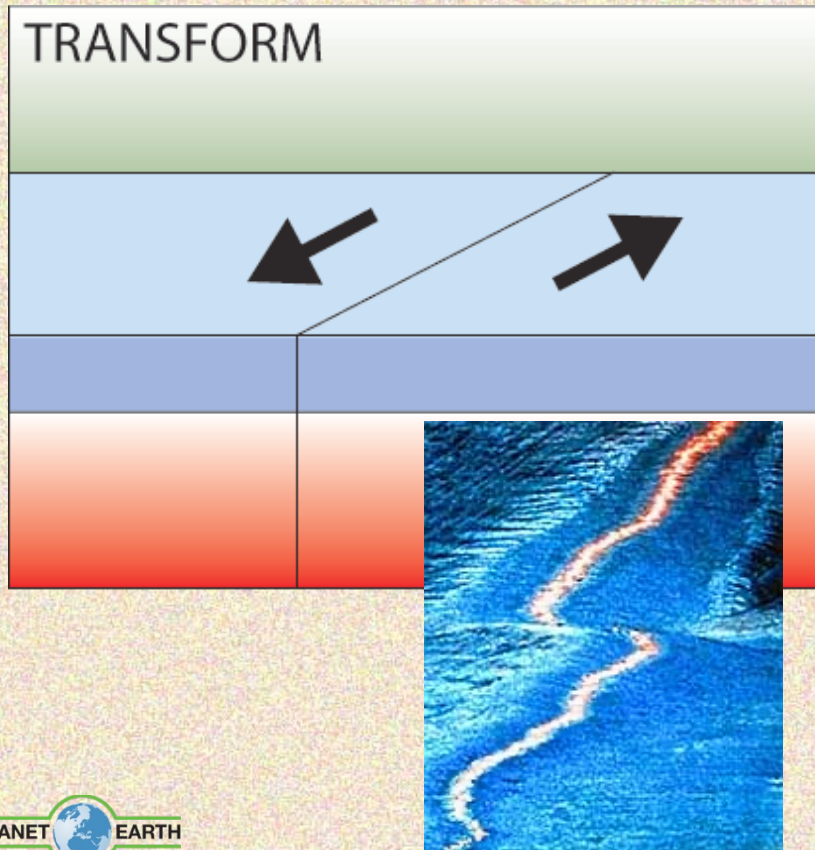
- When two oceanic plates collide, one runs over the other which causes it to sink into the mantle forming a **subduction zone**.
- The subducting plate is bent downward to form a very deep depression in the ocean floor called a **trench**.
- The worlds deepest parts of the ocean are found along trenches.
 - E.g. The Mariana Trench is 11 km deep!





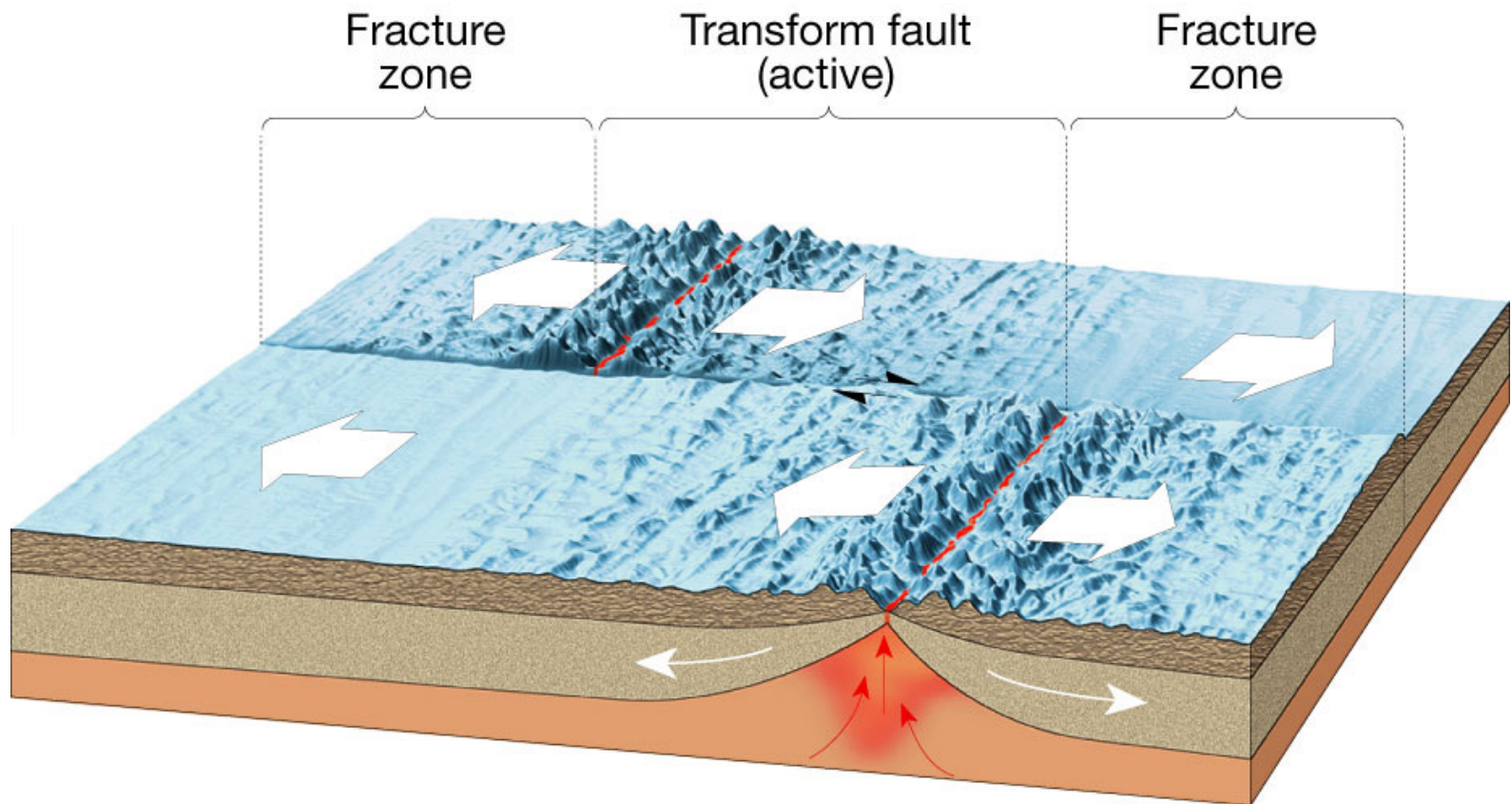
Transform Boundaries

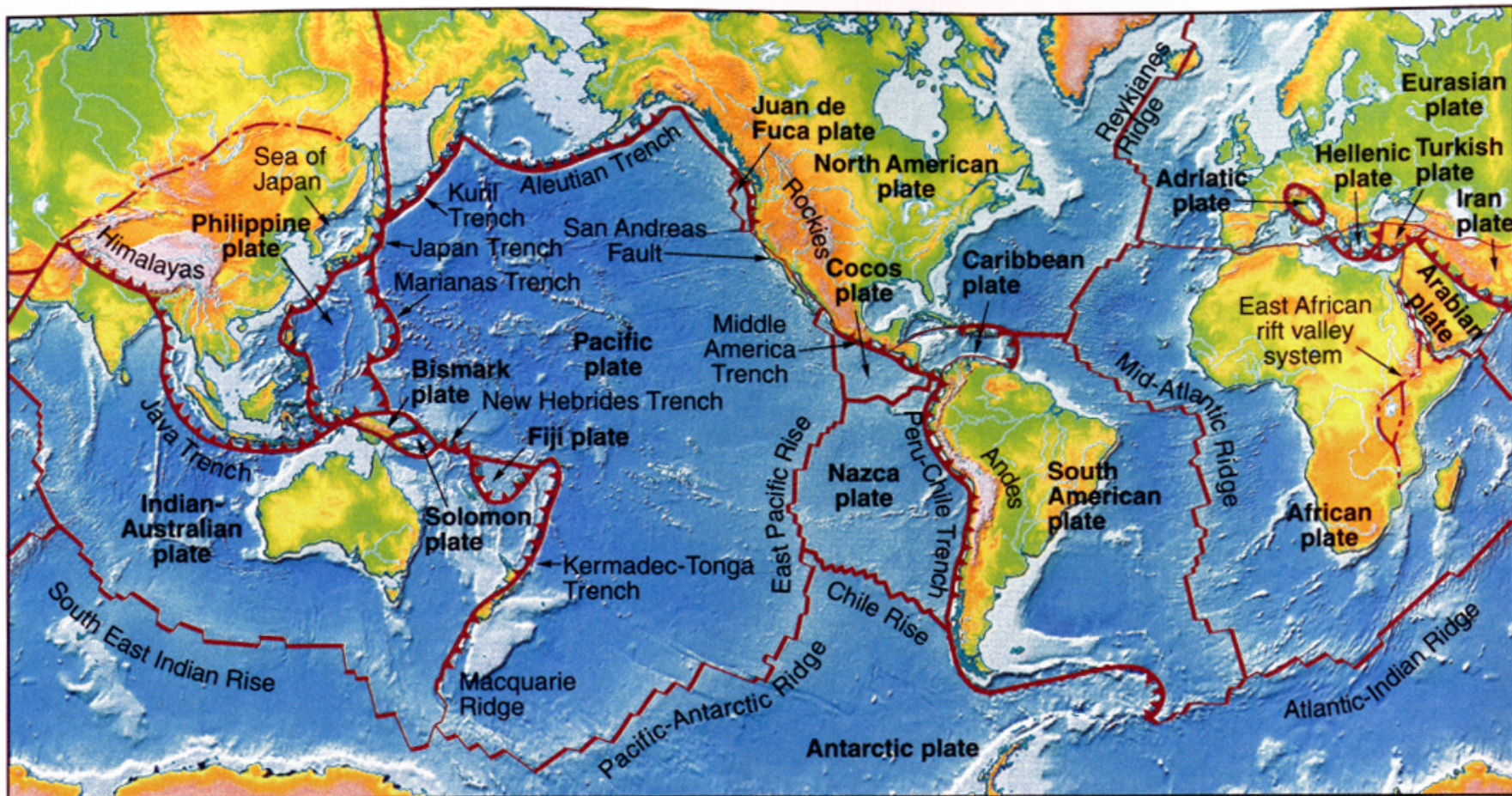
- Where plates slide past each other




Above: View of the San Andreas transform fault


Transform Fault Boundary






 Ridge axis
divergent boundary

 Transform

 Subduction zone
Convergent boundary

 Zones of Extension within continents

 Uncertain plate
boundary

Earth Plate



Practical Exercise 2

Where will the UK be in:

1,000 years?

1,000,000 years?

1,000,000,000 years?

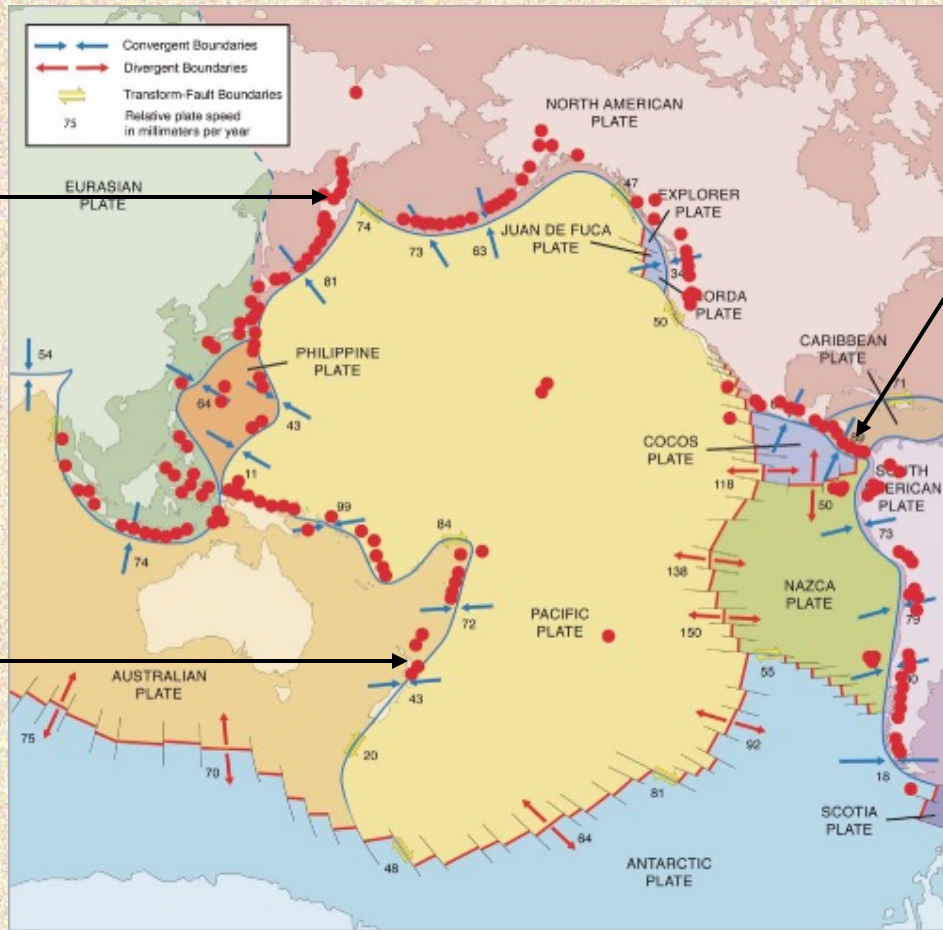


Volcanoes and Plate Tectonics...

...what's the connection?



Pacific Ring of Fire



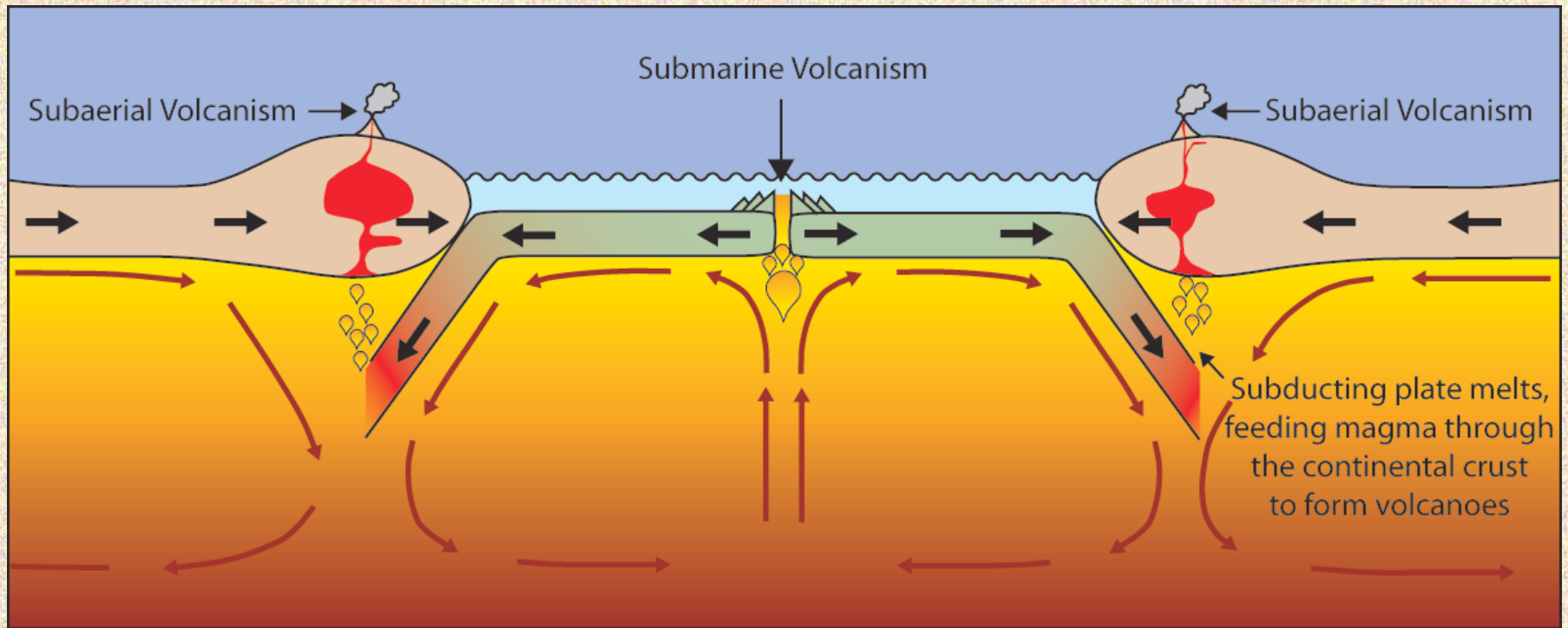
Volcanism is mostly focused at plate margins



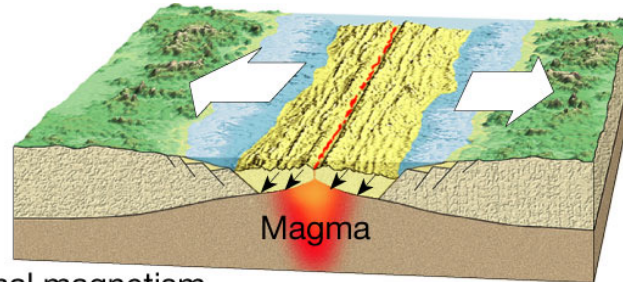


Volcanoes are formed by:

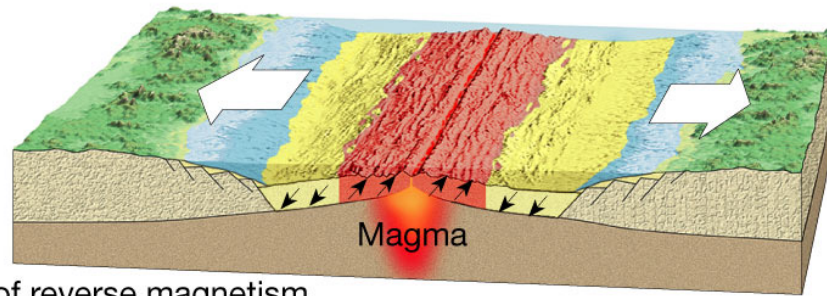
- Subduction
- Rifting
- Hotspots



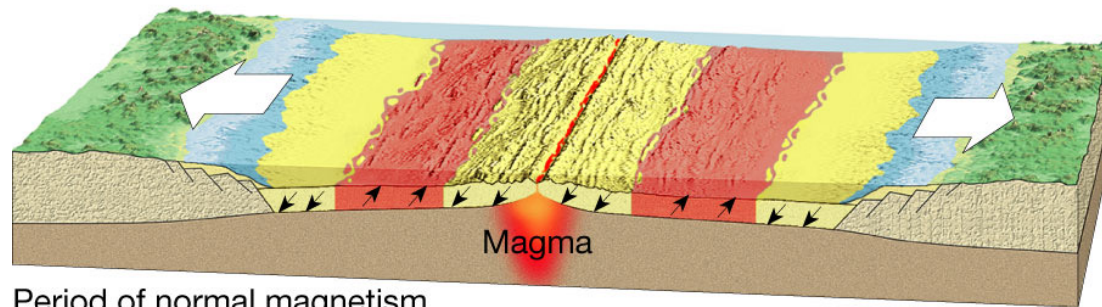
Polarity of the Ocean Crust



Period of normal magnetism

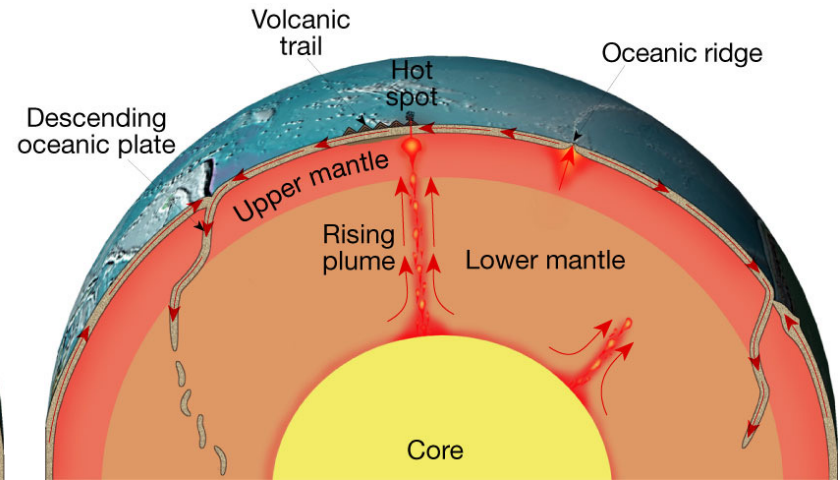
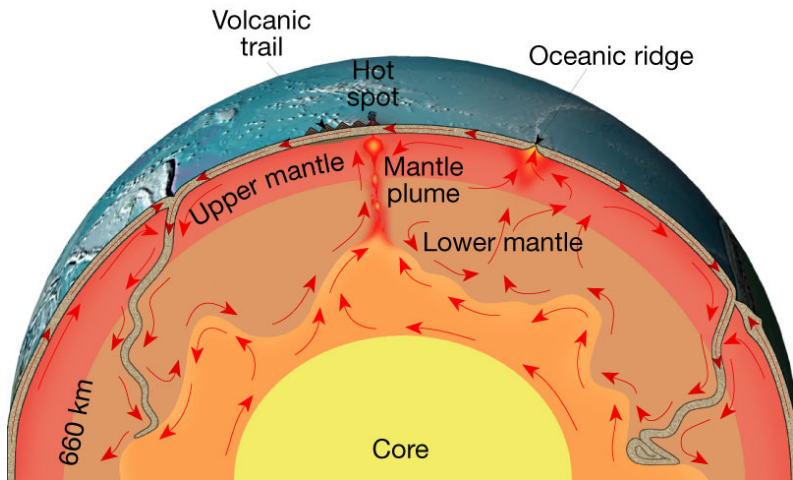


Period of reverse magnetism



Period of normal magnetism

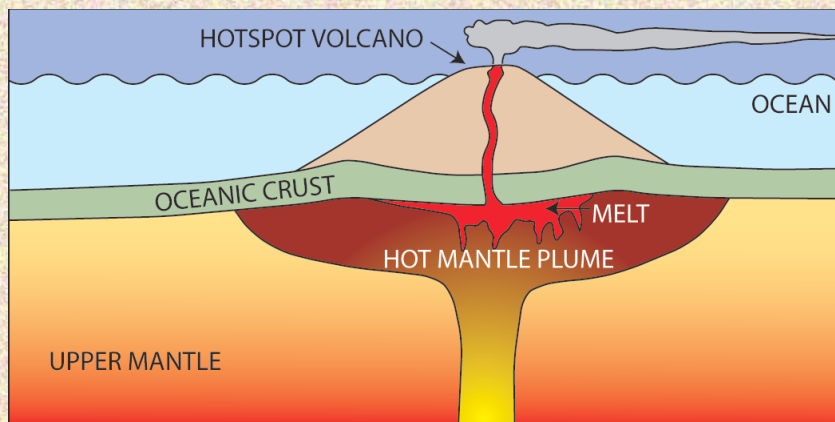
Mantle Convection Models





What are Hotspot Volcanoes?

- Hot mantle plumes breaching the surface in the middle of a tectonic plate



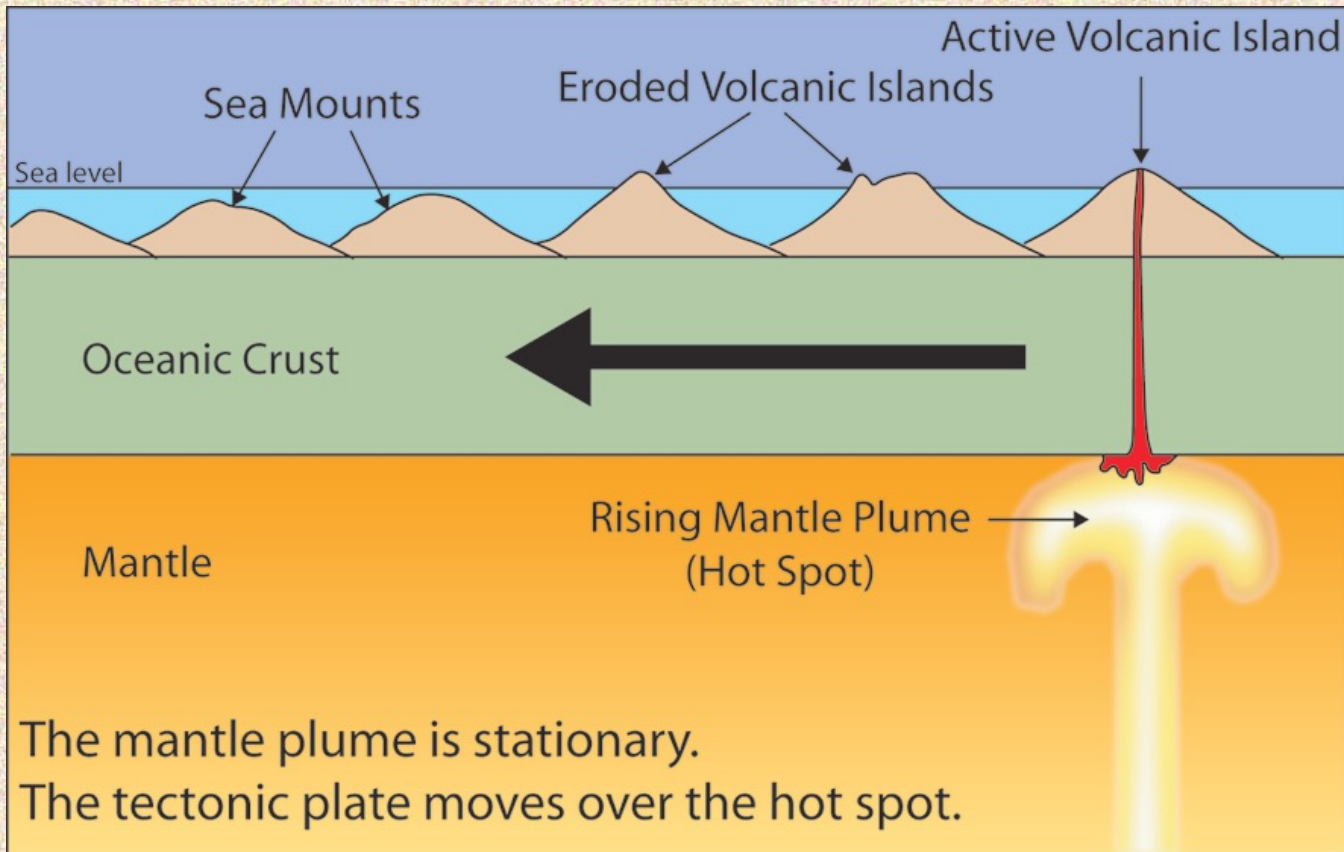
The Hawaiian island chain are examples of hotspot volcanoes.



Photo: Tom Pfeiffer / www.volcanodiscovery.com



The tectonic plate moves over a fixed hotspot forming a chain of volcanoes.



The volcanoes get younger from one end to the other.



Earthquakes and Plate Tectonics...

...what's the connection?



- As with volcanoes, earthquakes are **not** randomly distributed over the globe

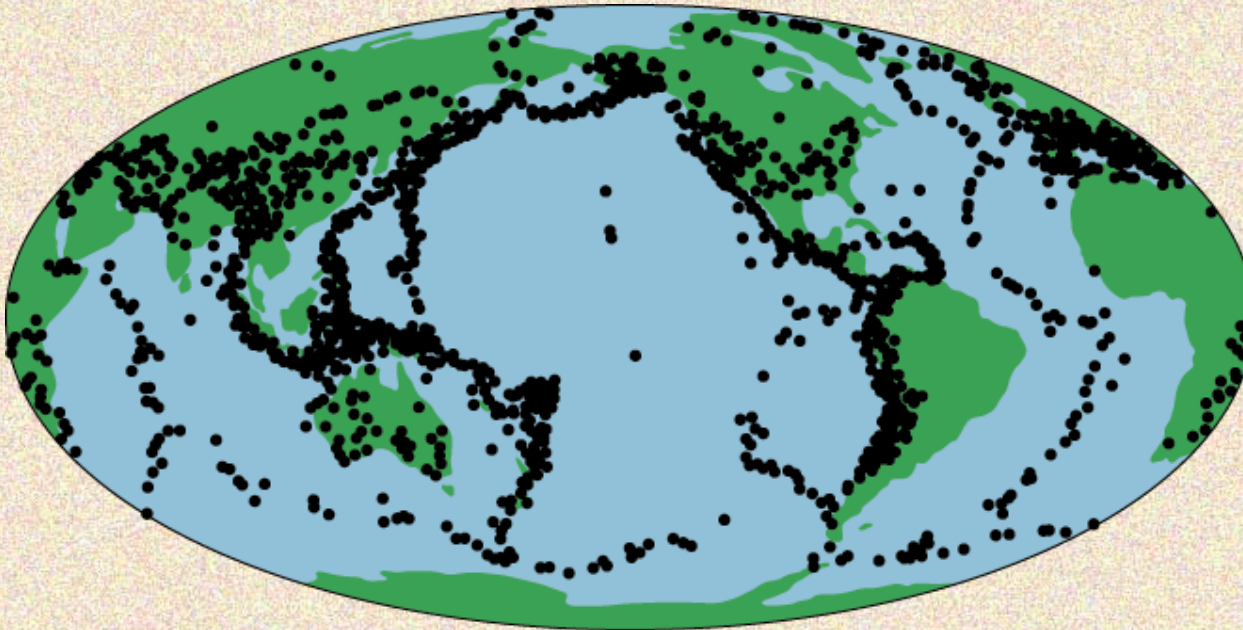


Figure showing the distribution of earthquakes around the globe

- At the boundaries between plates, friction causes them to stick together. When built up energy causes them to break, earthquakes occur.



Where do earthquakes form?

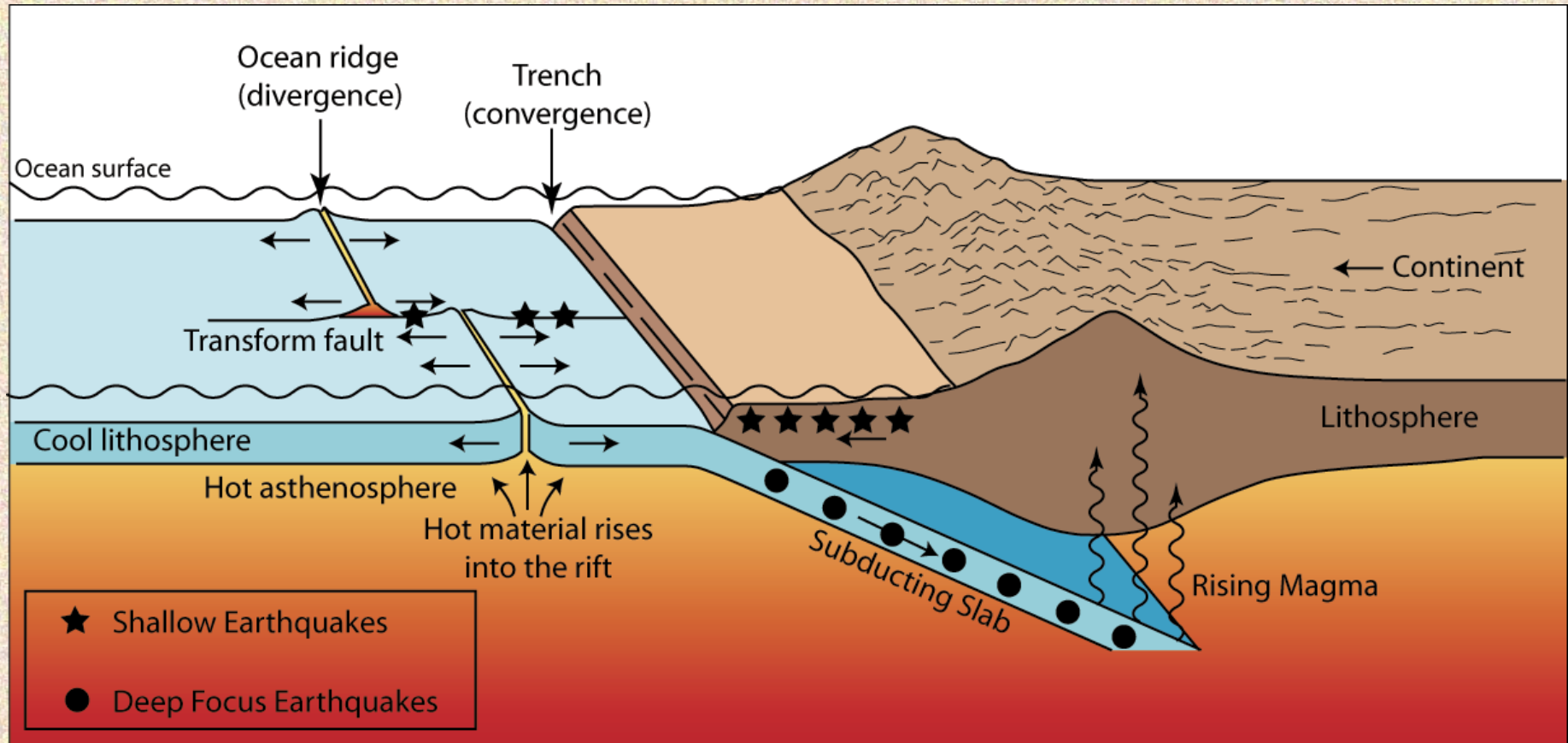


Figure showing the tectonic setting of earthquakes



Plate Tectonics Summary

- The Earth is made up of 3 main layers (core, mantle, crust)
- On the surface of the Earth are tectonic plates that slowly move around the globe
- Plates are made of crust and upper mantle (lithosphere)
- There are 2 types of plate
- There are 3 types of plate boundaries
- Volcanoes and Earthquakes are closely linked to the margins of the tectonic plates