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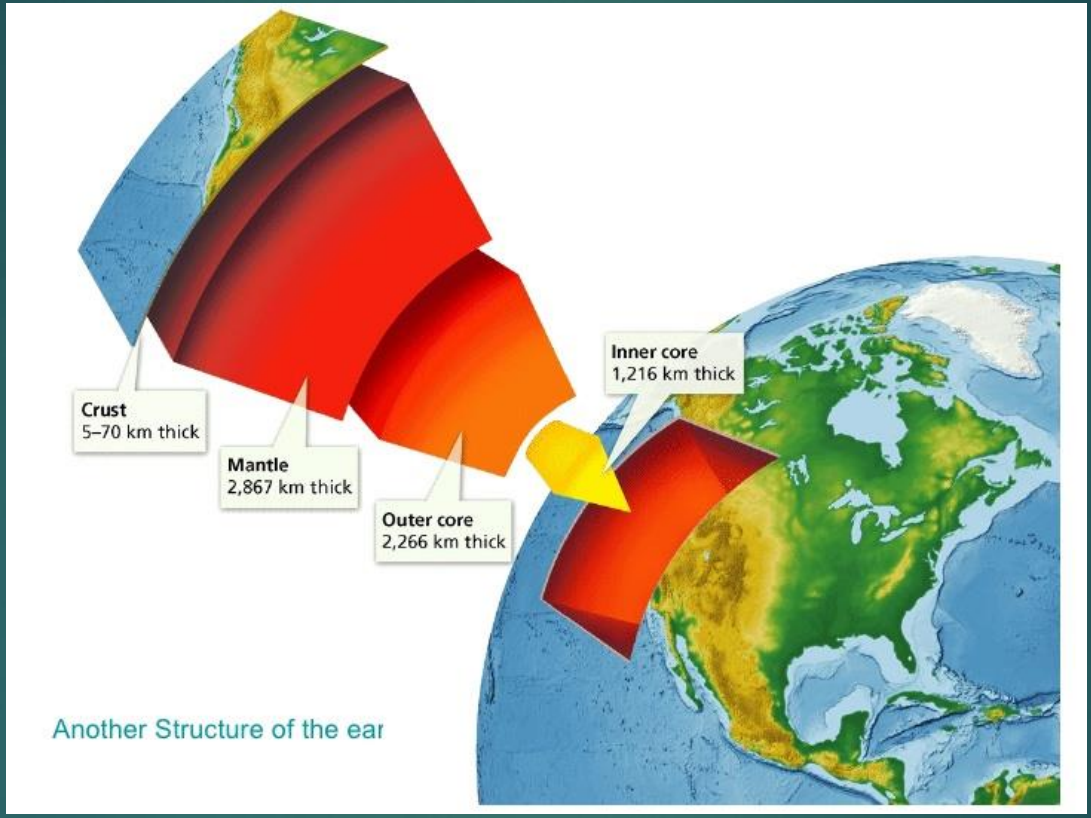
Classe VB- Prof.ssa G. Cilona

CLIL

Apprendimento integrato di Inglese e Scienze della terra

«The Theory of Tectonic Plates»

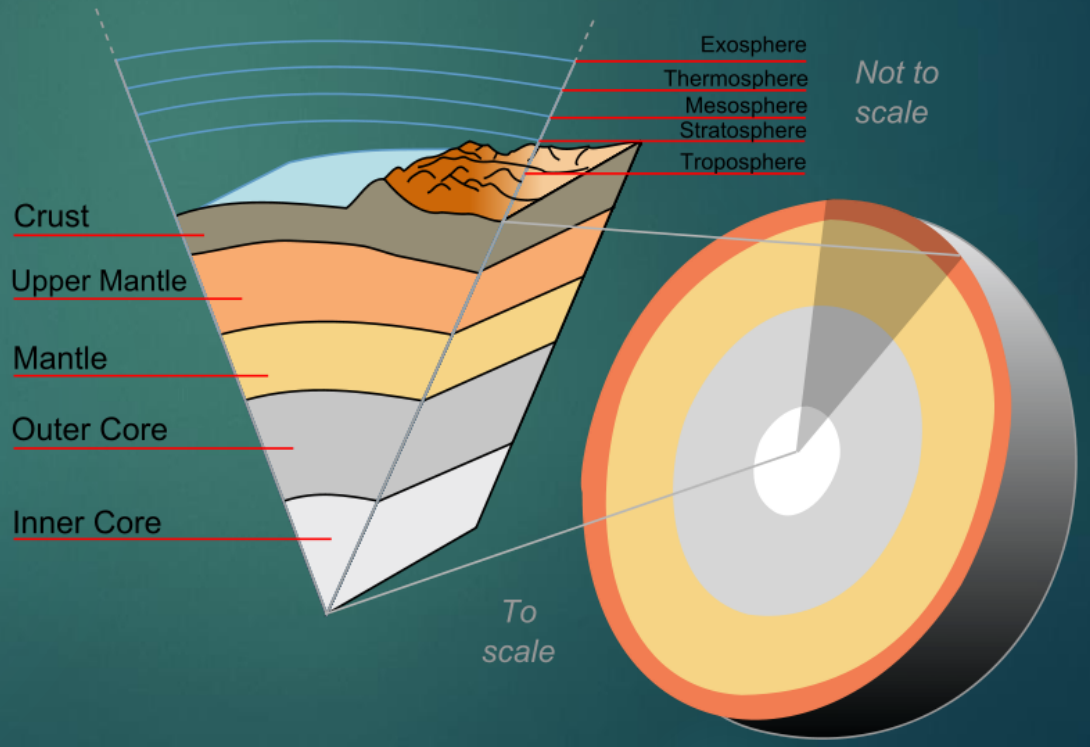
A TRIP INSIDE THE EARTH



A KNOWLEDGE OF EARTH'S INTERIOR IS ESSENTIAL FOR UNDERSTANDING PLATE TECTONICS

THE STRUCTURE OF THE EARTH

- CORE (INNER AND OUTER)
- MANTLE (INNER AND UPPER)
- CRUST



THE CORE

Is the «heart» of our planet. It is made up of:

- **INNER CORE** is a solid ball made of metal.

  Temperature: about 5000-6000 °C.

  Composition: NiFe (Nickel and Iron) alloy.

  Thickness: 1250 km thick and is the second smallest layer of the Earth.

- **OUTER CORE** is a magma like liquid layer that surrounds the Inner Core.

  Temperature: about 4000-5000°C.

  Composition: iron and some nickel.

  Thickness: 2200 km thick and is the second largest layer of the Earth.

  Magnetism: Because the outer core moves around the inner core, Earth's magnetic field is created.

THE MANTLE

Is mostly-solid bulk of Earth's interior. It lies between Earth's dense, super heated core and its thin outer layer, the crust.

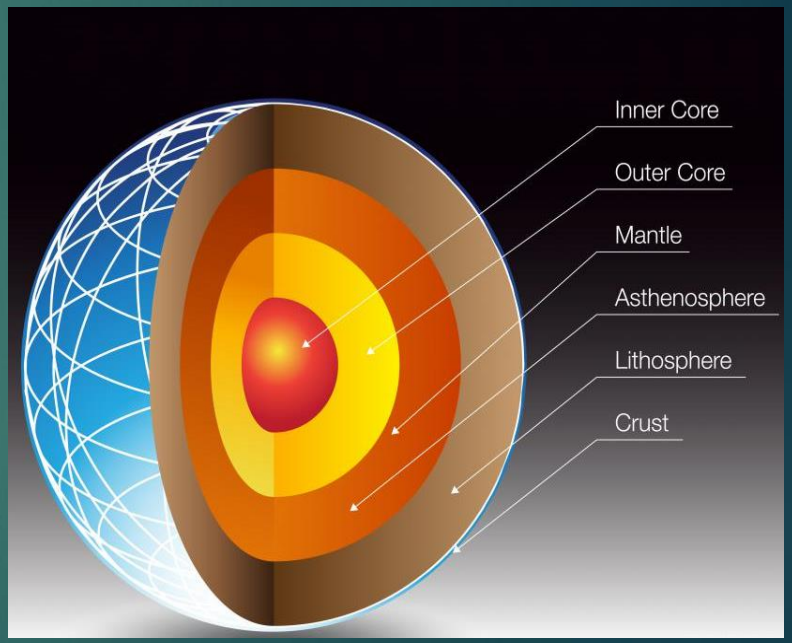
- Temperature: the average temperature of the mantle is 3000°C. Its temperature will become much hotter as getting closer to the Inner Core.
- Composition: the mantle is composed of silicates of iron and magnesium, sulphides and oxides of silicon and magnesium.
- Thickness: about 2900 km thick. It is the largest layer of the Earth, taking up 84% of the Earth.

The mantle is the thickest part of the planet and can be subdivided into LOWER and UPPER Mantle. Two parts of the Upper Mantle are often recognized as distinct regions in Earth's interior: the Lithosphere and the Asthenosphere. The Lower Mantle is usually recognized as Mesosphere. In geology, the Mesosphere refers to the part of the Mantle below the Litosphere and the Astenosphere, but above the Outer Core.

THE MESOSPHERE

is in the lower liquid portion of the mantle ranging from 640 km below the surface to 2890 km below the surface.

- Temperature and Composition: can soar to over 3800 °C. Because of these super high temperatures, the mesosphere is made up of dense rock that is very hot and exists in a non-quite-solid form.
- Thickness: 2250 km thick.

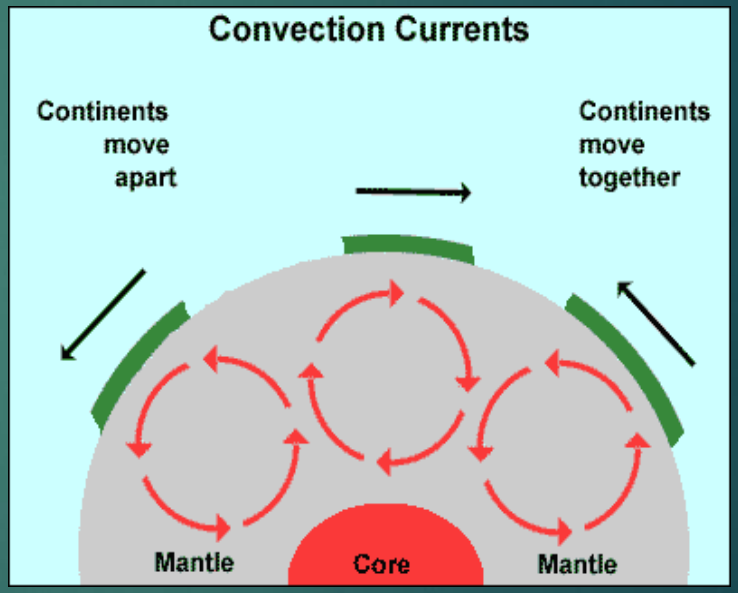


The lower the mantle is, the more fluid is the rock that composes it.
This fluidity, along with convection, resistance friction and electric currents, causes SEISMIC ACTIVITY.

THE ASTENOSPHERE

is the bottom layer of the upper mantle.

- Composition: it is a plastic like liquid made up of silicates of iron and magnesium.
- Temperature: about 4500°C. It is hotter than the lithosphere because it is closer to the core.
- Thickness: approximately 180 km thick. It is highly ductile so it can change shape and thickness depending on conditions.



Inside the astenosphere there are flows called

CONVECTION CURRENTS.

THE LITHOSPHERE

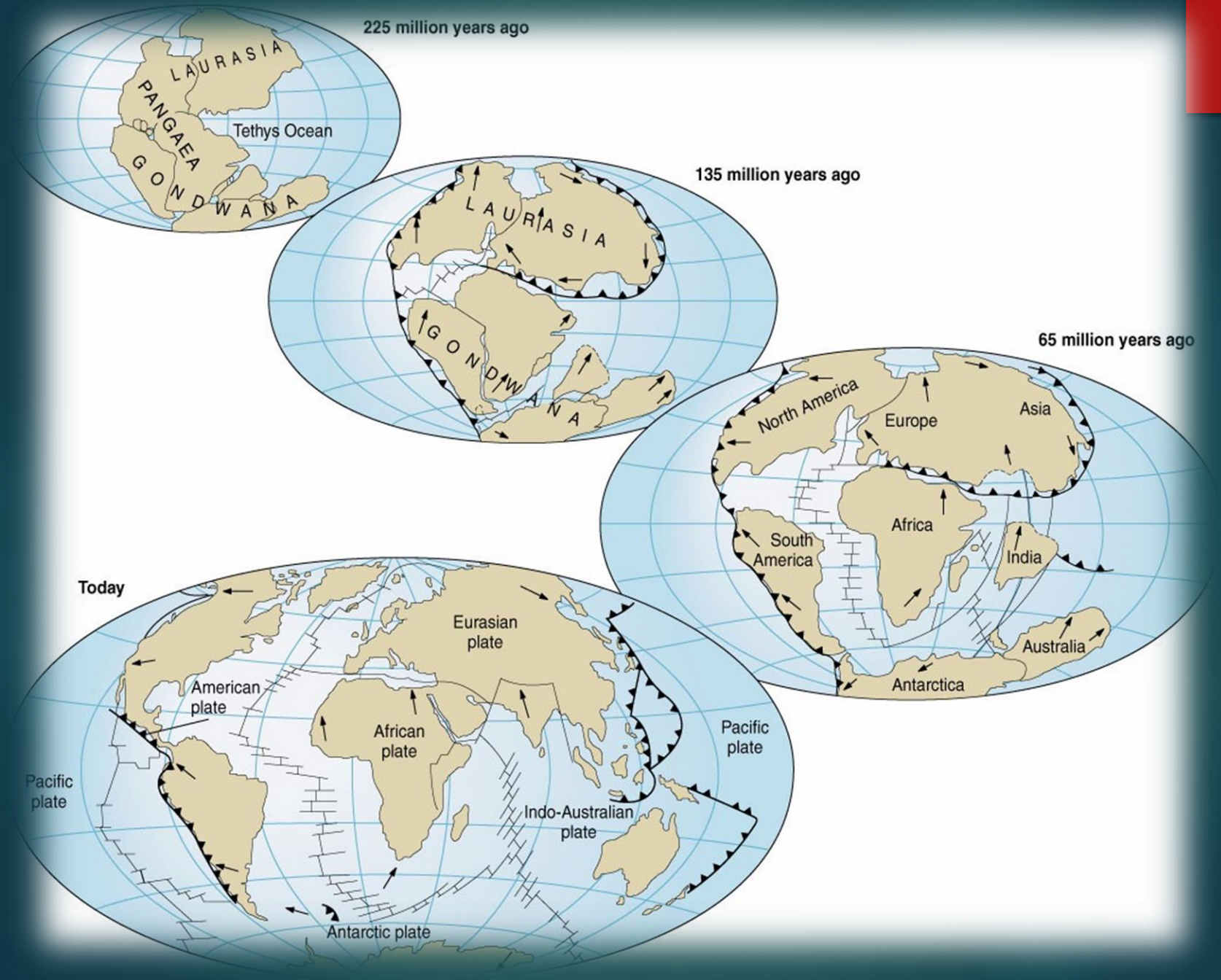
is the outermost layer of the upper mantle. It is the only part of the earth that is accessible to us.

- Composition: made up of eight elements (Oxygen, Silicon, Calcium, Sodium, Magnesium, Aluminum, Potassium and Iron).
- Temperature: does not have a specific temperature. Indeed, the temperature varies with depth and location. It can range from a crustal temperature of 0°C to an upper mantle temperature of 500°C.
- Thickness: about 70 km to 100 km thick. It is 6370 km distant to the center of the Earth.

THE CRUST

Is the absolute outermost layer of the Earth, which constitutes just 1% of the Earth's total mass.

- Composition: composed of a variety of igneous, metamorphic and sedimentary rocks and is arranged in a series of tectonic plates.
- Temperature: as its outer edge, where it meets the atmosphere, the crust's temperature is the same as that of the air.
- Thickness: it varies depending on where the measurements are taken, ranging from 30 km thick where there are continents to just 5 km thick beneath the oceans.


225 million years ago
LAURASIA
PANGAEA
GONDWANA
Tethys Ocean
135 million years ago
LAURASIA
GONDWANA
65 million years ago
North America
Europe
Asia
Africa
South America
India
Australia
Antarctica
Today
Eurasian plate
American plate
African plate
Pacific plate
Pacific plate
Indo-Australian plate
Antarctic plate

At the beginning of the 900th century the most accepted theories, concerning the movement of Earth's crust, were those FIXISTES.

The main model of this theory was that of ***a cooling down Earth*** where different materials became stratified based on their thickness.

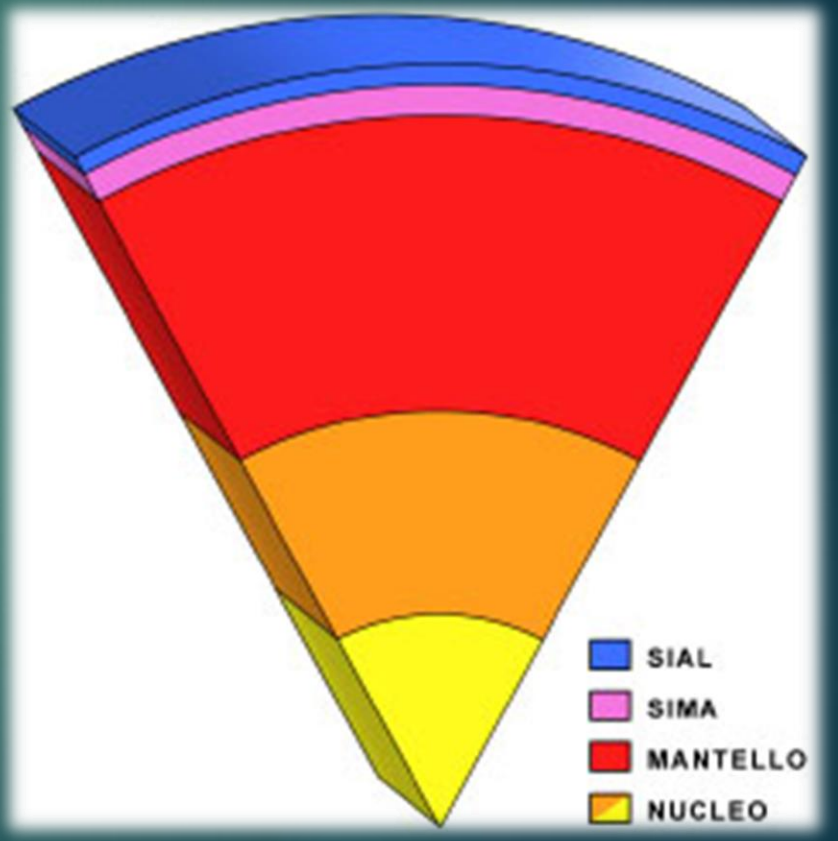
In particular, in fixists' opinion

Earth was formed by

different layers:

- SIAL: composed by granite rocks;
- SIMA: composed by basic rocks;
- OSOL: composed by sulphides;
- NIFE: the nucleus,

composed by nickel and iron.

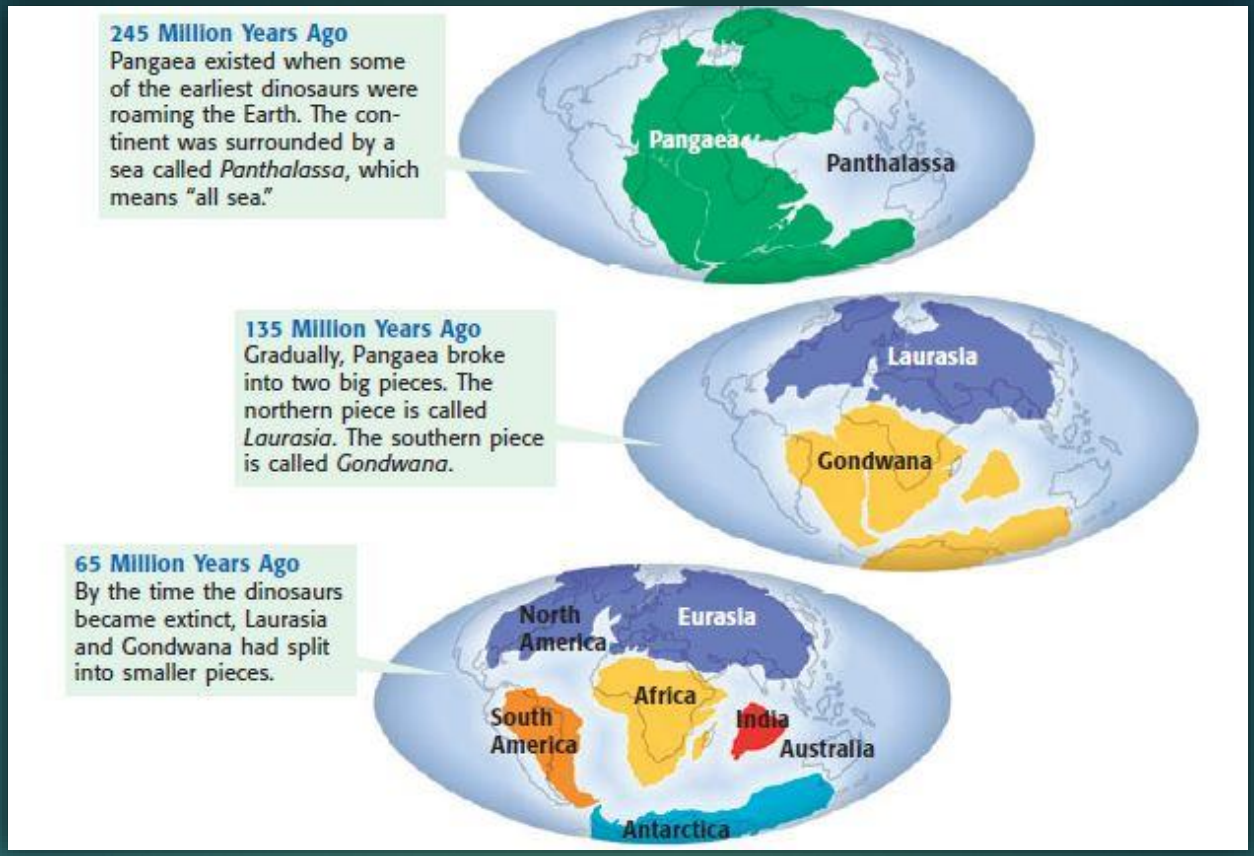


In 1912 the german weatherman **Alfred Wegener** exposed the

Theory of continental drift.

He talked about the existence of a supercontinent called PANGEA which was surrounded by an only big ocean called PANTHALASSA.

In Wegener's opinion Pangea fractured 200 million years ago to create more continental blocks that drifted on the Sima.

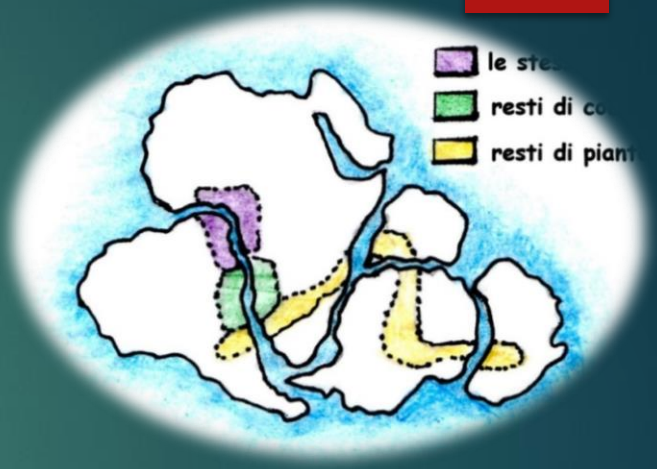


Inside Pangea could be distinguished:

- **LAURASIA**: including North America, Europe and Asia;
- **GONDWANA**: including South America, Africa, India, Madagascar and Australia.

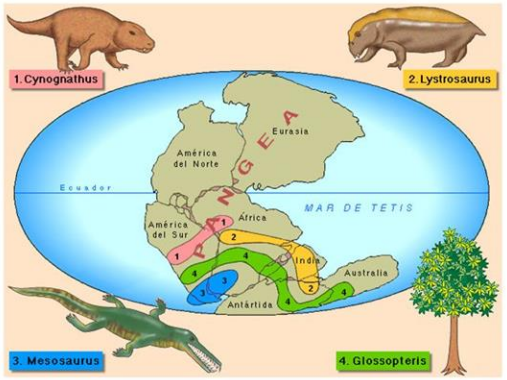
The theory was supported by:

- **GEOLOGICAL EVIDENCE**: Wegener detected correspondances with the continental borders, in fact assembling the continental blocks they will perfectly fit as they were pieces of a puzzle.



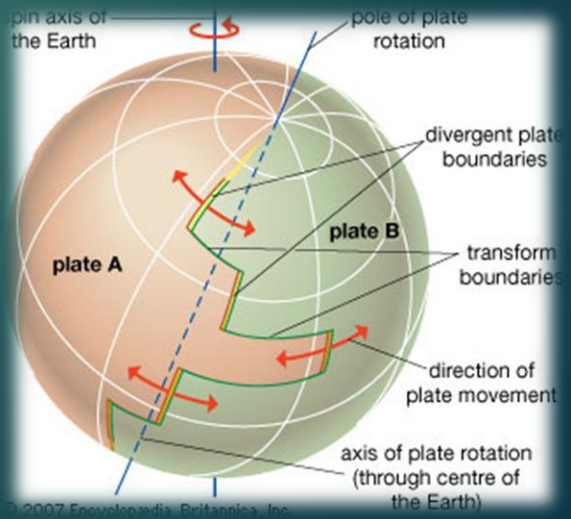
- **PALEONTOLOGICAL EVIDENCE**: there were also similarities between fossil flora and fauna. Until now, paleontologists explained these discoveries with the existence of continental bridges. According to Wegener the continental separation happened in later times to the disappearance of the species considered.

Continents change position over time



- **PALEOCLIMATIC EVIDENCE**: some rocks and fossils could be examples of particular weather conditions. In order to justify a so large distribution of rocks of the some age, typical of cold climate, it needs to suppose a whole glaciation of the South hemisphere and a tropical situation of the North hemisphere. It's easier to explain that in the Carboniferous the southern continents were in the polar region and only later they separeted.

- **GEOPHYSICAL EVIDENCE**: Wegener supposed that continents could move also horizontally as well as vertically, on a more fluid substratum.

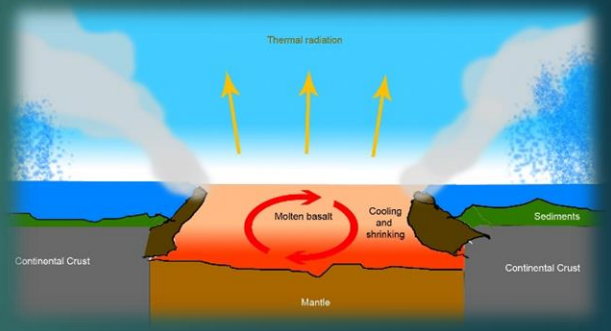


ISOSTASY:

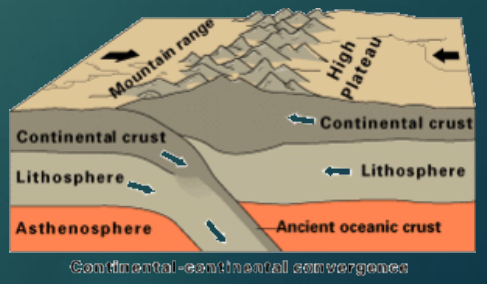
Phenomenon of continents' stabilisation

It's the state of gravitational equilibrium between Earth's crust and mantle such that depends on its thickness and density.

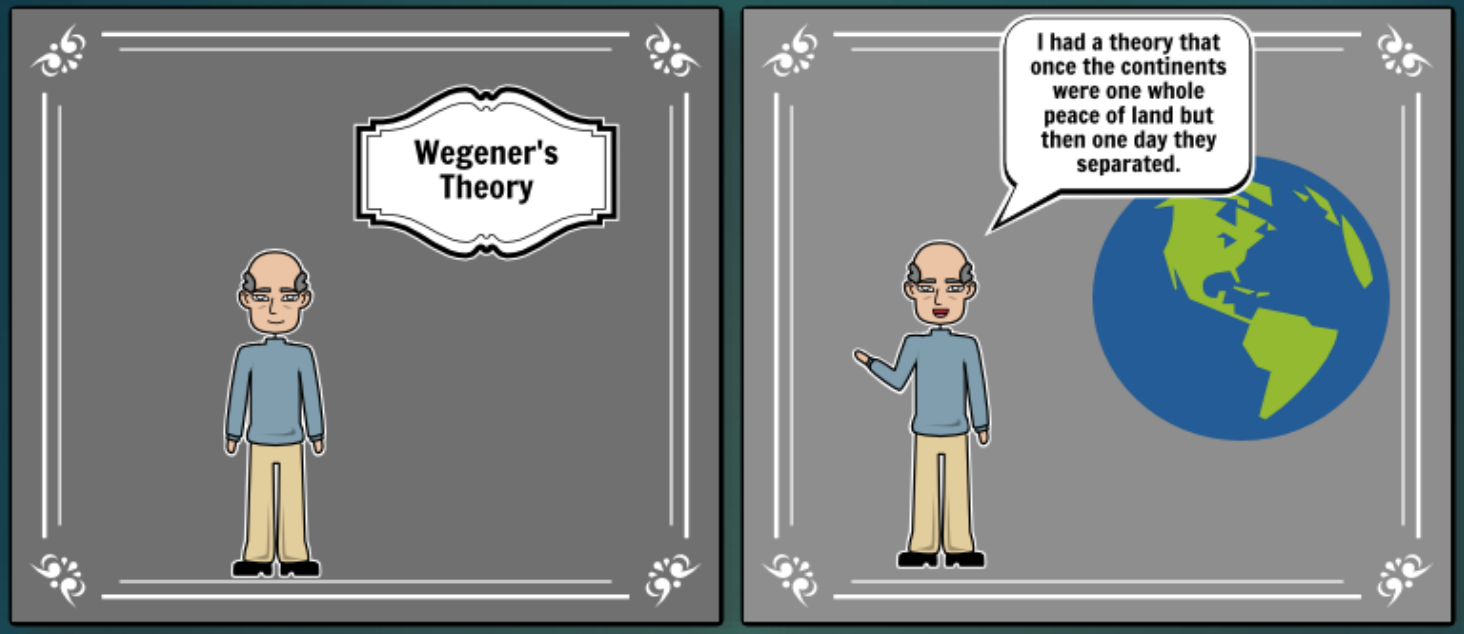
- **OCEANS**: they are made up of the disruption of continental mass, so that the 2 margins drift apart.



- **MOUNTAIN CHAINS**: they are made up of the collision between continents, with the closure of the ocean in the middle.



Continental-continental convergence

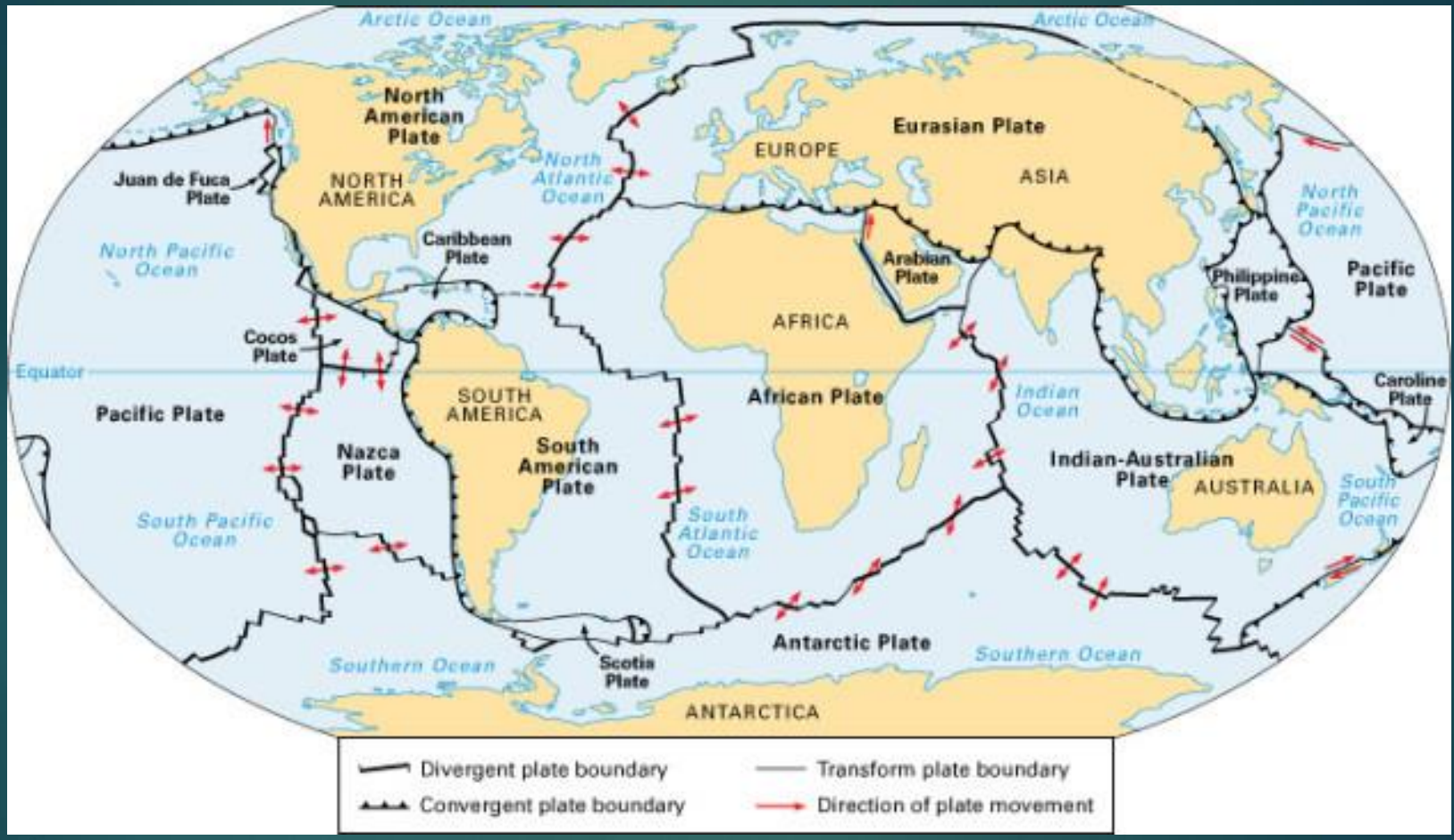


Wegener wasn’t a geologist and was not taken into account, the main critique against his theory sprang from the fact that he didn’t menage to explain the reason of the Pangea fracture.

Wegener set the basis for the formulation of the

PLATE TECTONICS THEORY

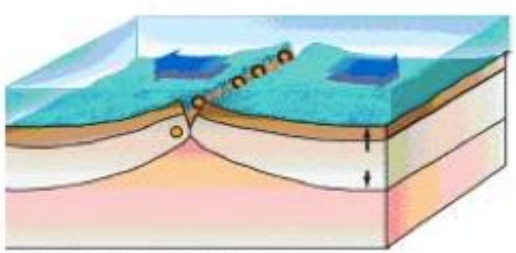
PLATE TECTONICS



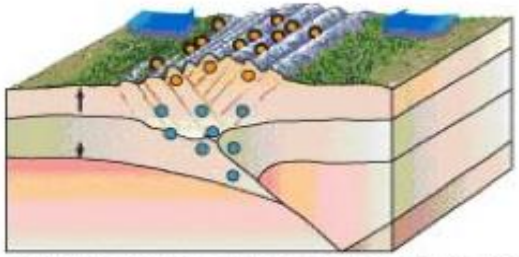
The earth's crust is divided in 12 major plates, which are moved in several directions.

There are three different types of plate boundaries:

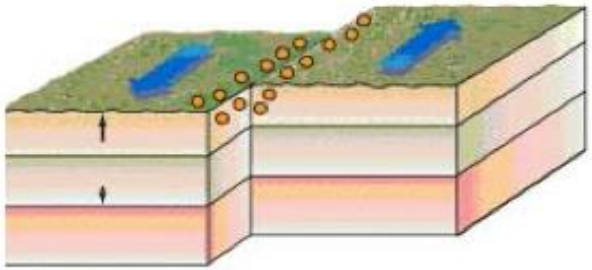
- Convergent Boundaries
- Divergent Boundaries
- Transform Boundaries



DIVERGENT BOUNDARY



CONTINENTAL COLLISION BOUNDARY

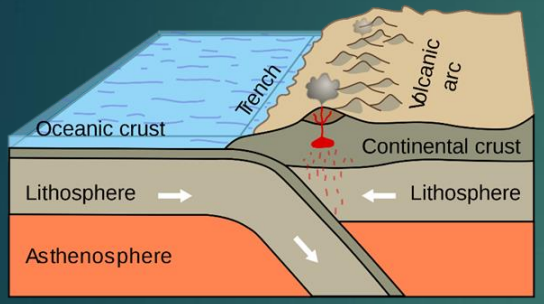


TRANSFORM FAULT BOUNDARY

Convergent Boundaries

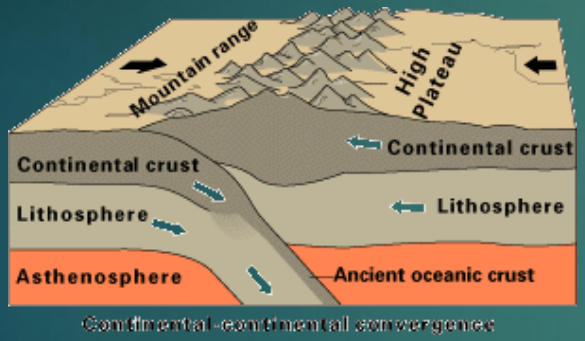
Convergent Boundaries are plates that collide, triggering either subduction or folding, which results in the creation of mountains.

Oceanic-Continental



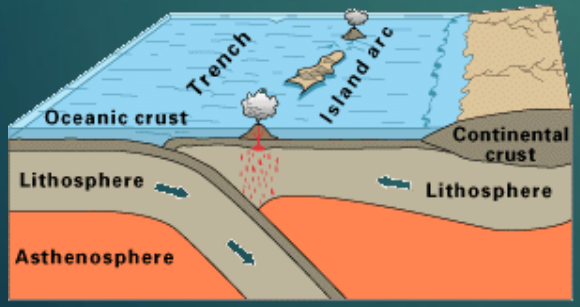
Realistic example:
The Ande Mountains

Continental-Continental



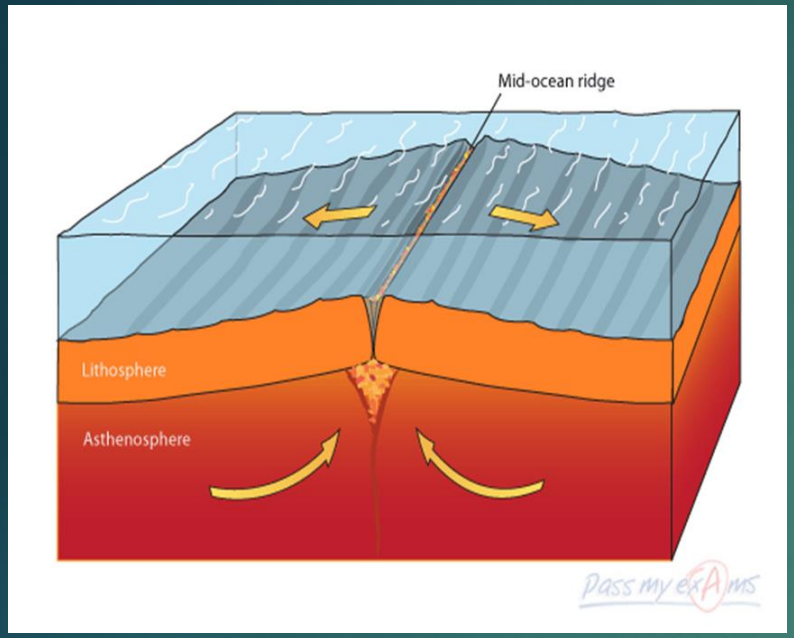
Realistic example:
The Himalayas

Oceanic-Oceanic



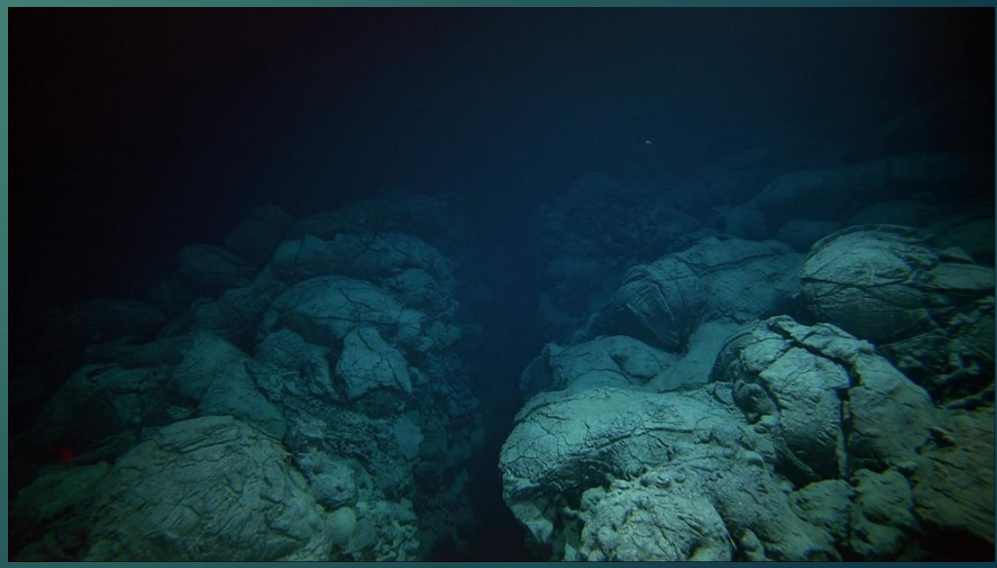
Realistic example:
The Auletian Islands

Divergent Boundaries



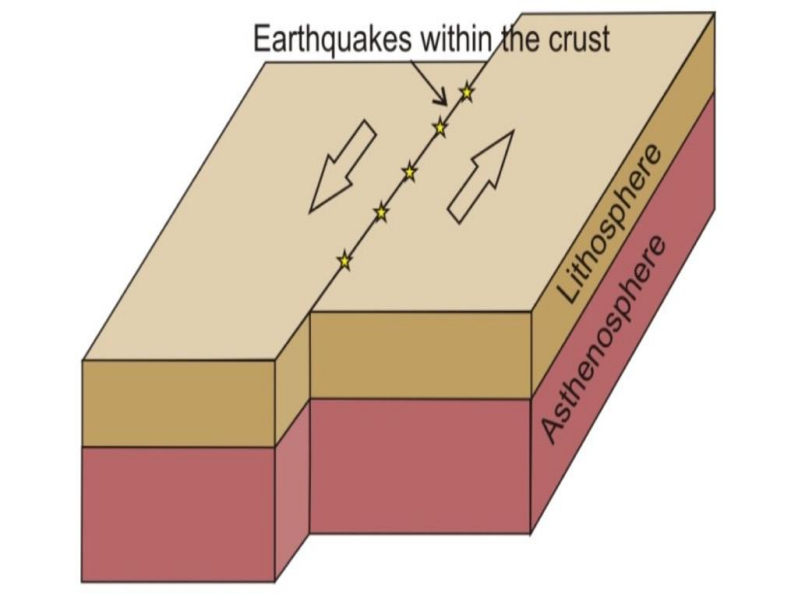
Divergent Boundaries are plates that are moving apart, causing magma to appear, which solidifies to generate a new crust.

Realistic Example:
Mid-Dorsal Ridges



Transform Fault Boundaries

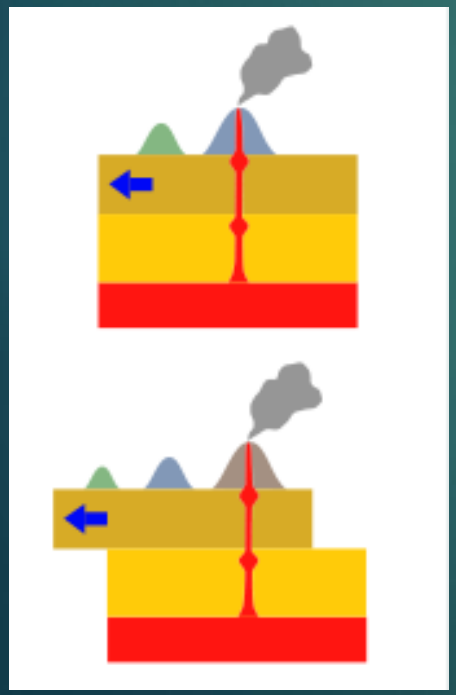
Transform Boundaries are plates that slide against each other, triggering earthquakes along faults of the same name.



Realistic example:
The Saint Andreas Fault

Hot Spots

Mantle plumes are areas of hot, upwelling mantle.
A hot spot develops above the plume. Magma generated by the hot spot rises through the rigid plates of the lithosphere and produces active volcanoes at the Earth's surface. As oceanic volcanoes move away from the hot spot, they cool and subside, producing older islands, atolls, and seamounts. As continental volcanoes move away from the hot spot, they cool, subside, and become extinct.

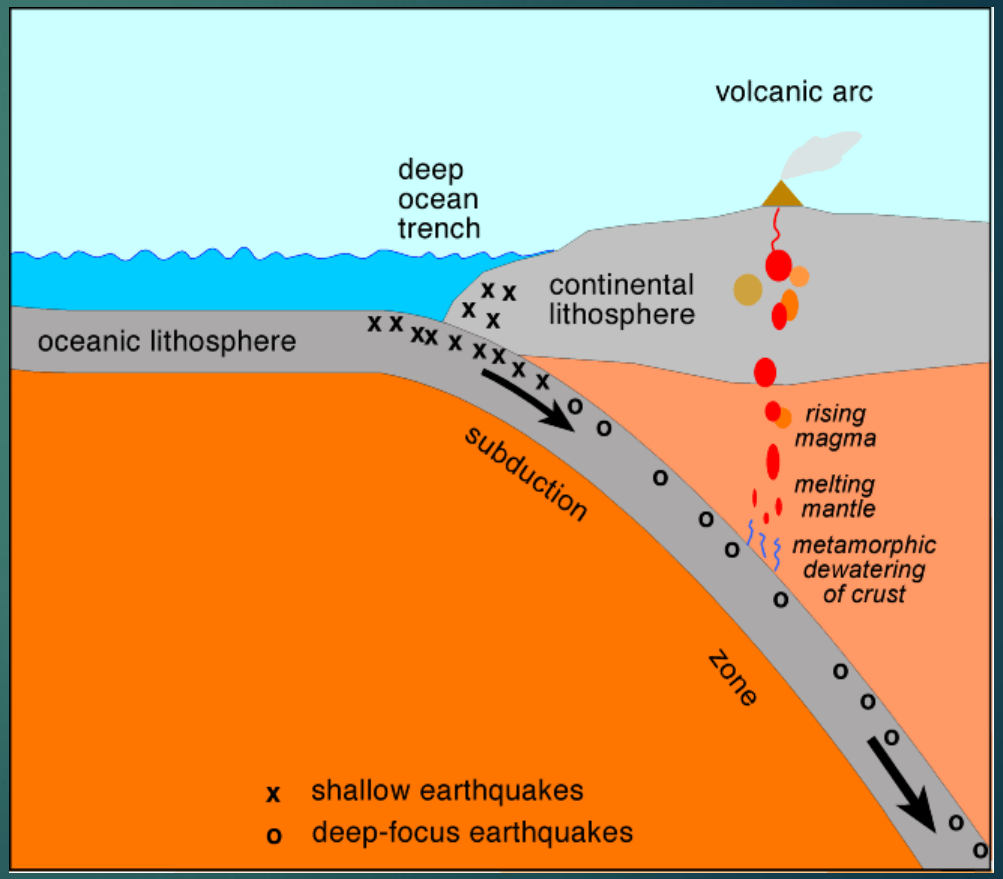


Realistic example:
Hawaiian Islands

Arc-trench system

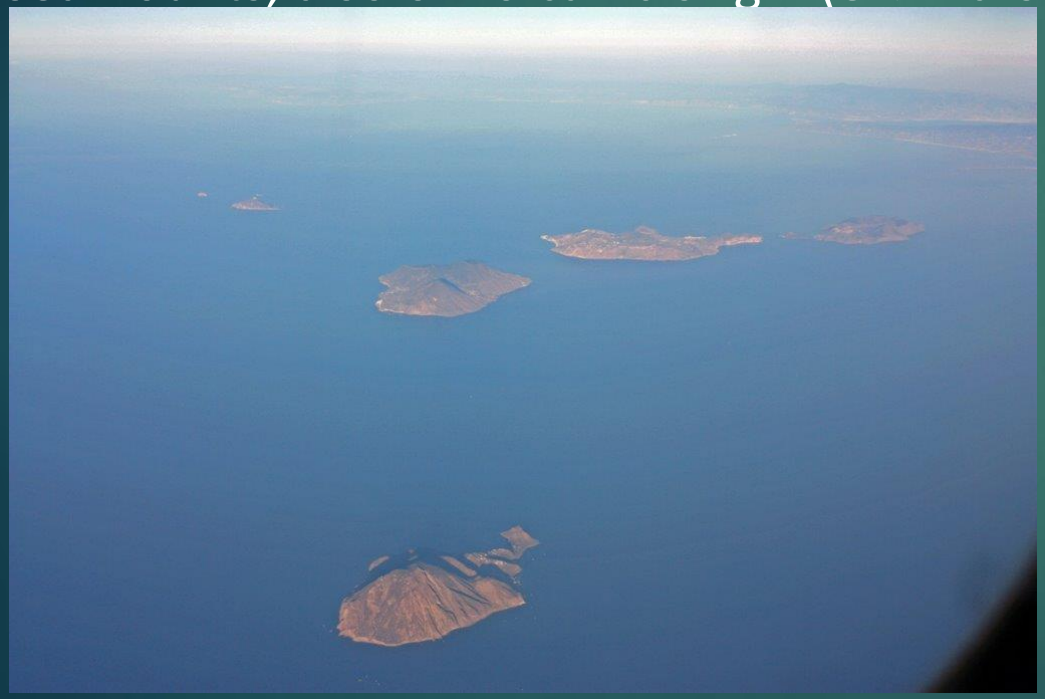
The arc-trench system is a set of structures typical of a convergent boundary, which is characterised by subduction. This system is made up of five elements:

- The trench;
- The accretion zone;
- The volcanic arc;
- The Benjoff zone;
- The Arc-trench gap.

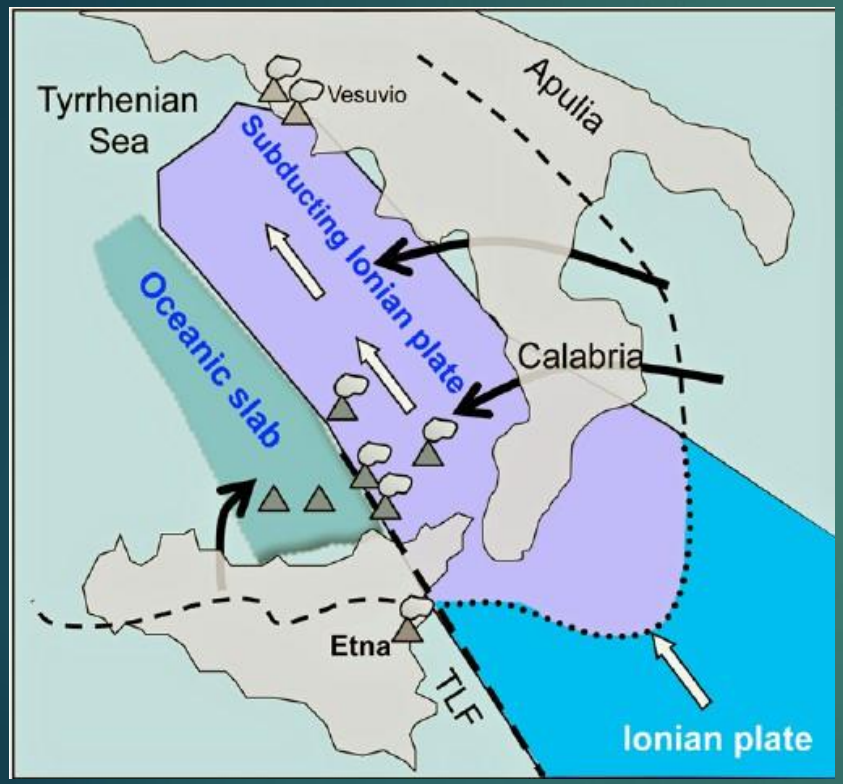


The Aeolian Islands: an example of arc-trench system in front of us

The Aeolian Arc is an island arc located in the continental slope of the Tyrrhenina Sea's ocean floor, thickness of 15-20 km.
The Aeolian archipelago is composed of seven islands, all of volcanic origin (Lipari, Vulcano, Salina, Stromboli, Panarea, Alicudi and Filicudi) and many seamounts, also of volcanic origin (ex. Marsilini and Lametini).



The commonly accepted hypotesis links the Aeolian magmatism to the phenomenon of subduction, still ongoing, of the oceanic Ionian lithosphere under the Calabrian arc.



The Aeolinan islands are actually located within the Calabrian arc, on the Sicilian and Calabrian oceanic slope which moves forward, northwest, up to the Tyrrhenian oceanic floor.

A deep and steep Benjoff zone has been recognized under the Calabrian arc, based on the distribution of earthquakes with intermediate (between 70 and 300 km of depth) and deep (beyond 300 km) epicentre.

The islands of Vulcano and Stromboli are still active volcanoes, and the latter often offers an amazing and suggestive show to tourists and residents.