Hartai Éva,

Geology

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A Műszaki Földtudományi Alapszak tananyagainak kifejlesztése a
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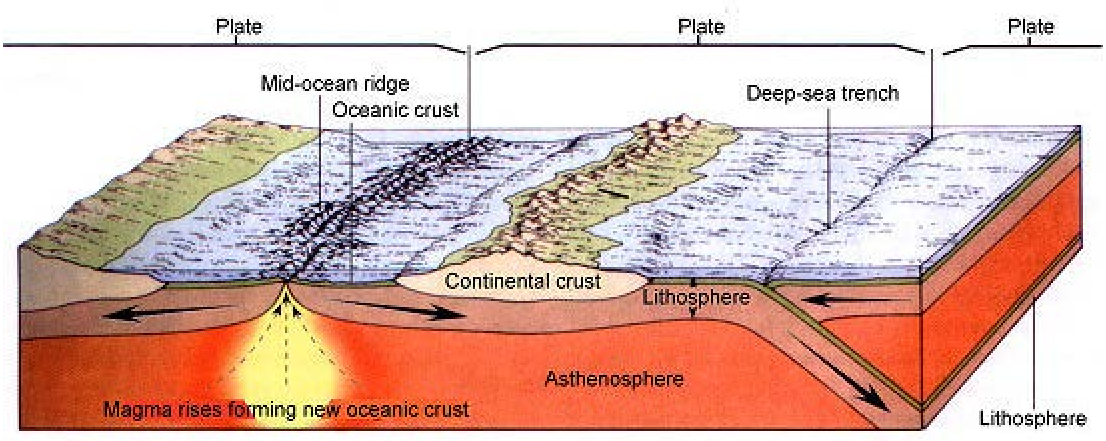
VII. Plate interiors

1. The basic concepts of plate tectonic theory

According to the acceptance of the theories of the continental drift and seafloor spreading, and as a result of the new geophysical research and interpretations, the theory of plate tectonics was established by the end of the late 1960s. This theory put all former geological interpretations on a new foundation. The elaboration of the theory was carried out by teamwork and several scientists took part in it, mostly Americans and Canadians. The recognition of plate tectonics is one of the most significant scientific discoveries in the 20th century and it is also said to be the most important discovery in geology.

The main statements of the theory can be summarized as follows:

- The outermost solid belt of Earth, the lithosphere, is not continuous but consists of larger pieces, so-called **plates**.
- The size, shape, geographic position and number of plates have changed during the Earth's history.
- The plates are in constant movement: they diverge, converge or slip along each other.
- The movement is caused by the convectional currents in the weak asthenosphere, which pull the rigid lithosphere plates. The currents are generated by the temperature differences inside the Earth.
- The plate interiors are relatively balanced areas; the active geological processes (earthquakes, volcanic activity) are limited mostly to the plate margins.



Schematic sketch of the plate tectonic processes [i]

Magma moves upward from the asthenosphere and forms new lithosphere capped by oceanic crust. The lithosphere moves away from the fracture zone and sinks slowly down into the asthenosphere, where it is heated and mixed again with the mantle.

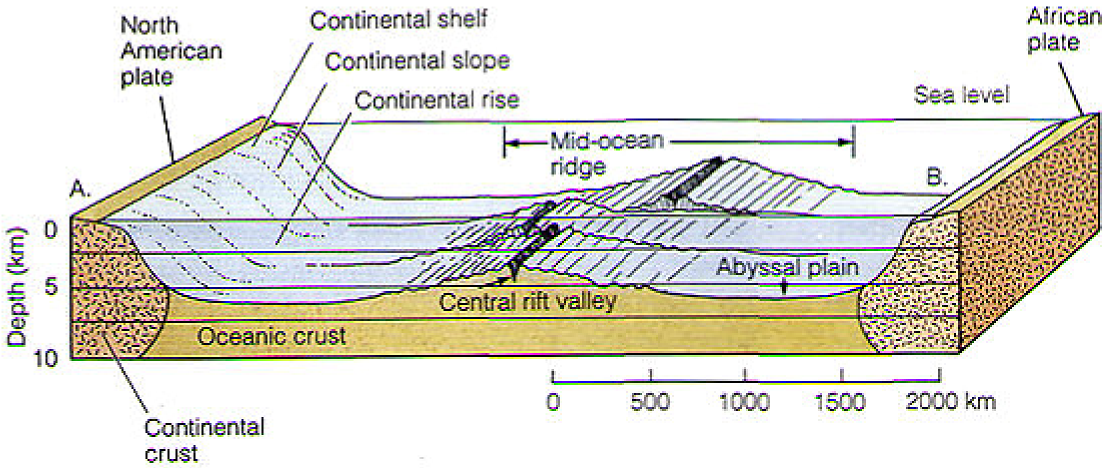
2. The characteristics of plate interiors

Oceanic plate interiors

Currently 71% of the Earth' surface is covered by oceans. Even if we take out from this the inland seas and the shelf areas, which have a continental basement, the rate of oceanic crust is significantly high on the Earth. Still we do not know much about the oceanic crust because of the difficulties of direct examination. Most of our knowledge about it comes from the collision zones where ancient oceanic lithosphere fragments are compressed to the continental crust.

Shorelines

The shorelines do not coincide with the boundaries between continental crust and oceanic crust. This is because some ocean water spills out of the ocean basin onto the continents. Therefore, the boundaries between ocean and continent are covered by seawater. As the marginal parts of the continental crust, the **shelf**, the **continental slope** and the **continental rise** are covered by water.



Simplified section of the Atlantic Ocean [ii]
The shorelines do not coincide with the geologic boundaries between the continental and oceanic crust.

In the oceanic plate interiors three kinds of morphological units can be distinguished: **abyssal planes**, **oceanic plateaus** and hot-spot **shield volcanoes**.

Abyssal planes

The abyssal plains are found at depths between 3,000 and 6,000 meters. Lying generally between the foot of a **continental rise** and a **mid-ocean ridge**, abyssal plains cover more than 50% of the Earth's surface. They are among the flattest, smoothest and least explored regions on Earth.

Abyssal plains are poorly preserved in the sedimentary record because they tend to be consumed by the subduction process. The abyssal plain is formed when the lower oceanic crust is melted and forced upwards by the asthenospheric convectional currents. As this basaltic material reaches the surface at mid-ocean ridges, it forms new oceanic crust. Abyssal plains result from the blanketing of an originally uneven surface of oceanic crust by *fine-grained sediments*, mainly *clay* and *silt*.

Oceanic plateaus

The oceanic plateaus rise from the abyssal plains but they are covered by water. Their origin is debated: they may be fragments of former plates or parts of ancient continents, which were broken off the continents by tectonic forces.

Shield volcanoes

The shield volcanoes are special forms of the oceanic areas. They are elevated above sea level and form islands with active **basalt volcanoes**. The source of this kind of volcano is a **hotspot**.

Hotspots are deep, long-lived magma sources, which lie far down in the mantle. When the oceanic plate moves slowly above the hotspot, a chain of the volcanic islands can be formed by the melting effect of the heat source. The best example of this is the *Hawaiian-Emperor island chain*.

Mauna Loa, a typical flat shield volcano on the island of Hawaii [iii]

Continental plate interiors

In the continental plate interiors we can find **cratons**, **old orogenic belts** and sediments of **epicontinental seas**.

Cratons

In the core of the continents we can find the ancient cratons. Although they have preserved the prints of several ancient deformation events, recently they are the most rigid parts of the Earth, and earthquakes do not occur in them. The oldest parts of the cratons are built up by *Archaean granite*, *gneiss*, *banded iron formations*, and other metamorphic rocks. Between the cratons, there are metamorphosed *greenstone belts*, which are interpreted as old collision zones. The metamorphic rock masses were intruded by *granite plutons*. Parts of the cratons are covered by old sedimentary sequences, which – despite their old age – remained unmetamorphosed, as they have not been involved in orogenic events.

Banded iron formation in the Pilbara Craton, Australia [iv]

Old orogenic belts

The old orogenic belts are found in recent continental areas. These are the *strongly deformed* collision zones of former continents, where the oceanic rocks are compressed, folded and lifted up. The rock composition of these belts is variable; fragments of oceanic and continental crust may occur as well as thick, deformed sedimentary sequences, volcanic and intrusive bodies.

Eroded mountains of an old orogenic belt in West Norway

Sediments of epicontinental seas

The continental margins can sink or rise in order to balance the plate tectonic movements. Thus, parts of continents can be temporarily covered by oceanic water. The process when the oceans intrude continents by the sinking of the edge of a continent is called **transgression**. This is how the epicontinental seas are formed, which have continental basement. The opposite movement **is regression**, which results in the retreat of the ocean water.

BIBLIOGRAPHY:

[i] Skinner& Porter, 1995

[ii] Skinner& Porter, 1995

[iii] http://martianchronicles.wordpress.com

[iv] Photo: Anna Seres