HARTAI ÉVA,

GEOLOGY

3

Új Magyarország FEJLESZTÉSI TERV

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III. Energy and the Dynamic Earth

1. Outer and Inner Energy Sources

According their origin and place, geological processes can be divided into two large groups. One is the so-called "**exogenous processes**", which means that these processes take place on the Earth’s surface and gain their energy from the Sun’s heat. *Weathering*, *erosion* and *sedimentation* belong to this group. The other group of processes is the "**endogenous processes**". These processes, like *magmatism*, *plate tectonics* and *earthquakes*, take place inside the Earth and use the Earth’s inner heat as an energy source.

Energy from the Sun reaches the Earth as heat rays. When heat rays hit a solid surface or pass through a gas or liquid, some of the heat is absorbed and the temperature of the absorbing body rises.

Approximately 60% of the Sun’s heat that reaches the Earth is absorbed by the land, the sea, or the atmosphere. The remaining 40% is simply reflected back into space. The absorbed heat controls temperature changes, precipitation, and wind.

The valley of the Hernad River as an example of erosion
Weathering and erosion are driven by the Sun’s energy.

The inner heat of earth comes from radioactive decay, crystallization, atomic structure modification, and the "remnant heat" of the early heat-producing processes (massive meteorite impacts), which partially melted the Earth.

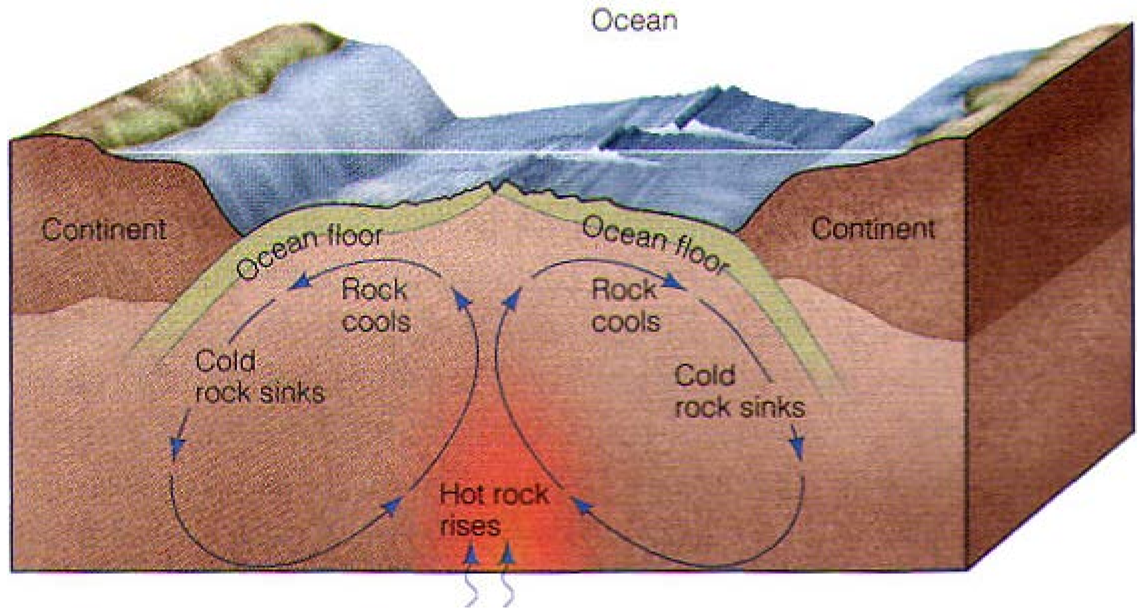
2. Conduction and convection

One of the fundamental laws of nature is that heat always flows from a hot place to cold one. Thus, heat must flow outward from the interior of the Earth toward the cool surface.

The process by which heat can move through solid rock, or any other solid body, without deforming the solid is called **conduction**. Conduction does not cause the movement of hot material from one place to another. The atoms remain in the crystalline structure and transport the heat by oscillation.

In gases and liquids, heat transport take place by **convection**. Convection, unlike conduction, does cause movement. It is the process by which hot, less dense materials rise upward and are replaced by cold, downward and sideward-flowing materials to create a convection current. In this case the particles transport heat by moving one place to the other. Convection is a faster means of heat transport than conduction.

Tests show that rocks do not have to melt before they can flow. Rocks, if sufficiently hot, can flow like sticky liquids, although the rates of flow are exceedingly slow (cm/year). The higher the temperature, the weaker the rock is and the more easily it will flow. Slow convection currents are possible deep inside the Earth because the interior is very hot. Convection currents bring hot rocks upward from the Earth's interior. The currents of hot rock flow slowly up, spread sideways, and eventually sink downward as the moving rocks cool and become denser.



***Convection in the asthenosphere* [i]**
The rising hot rocks and sideways flows are thought to be the factors that control the positions of ocean basins and continents, which means that convection determines the Earth's surface.

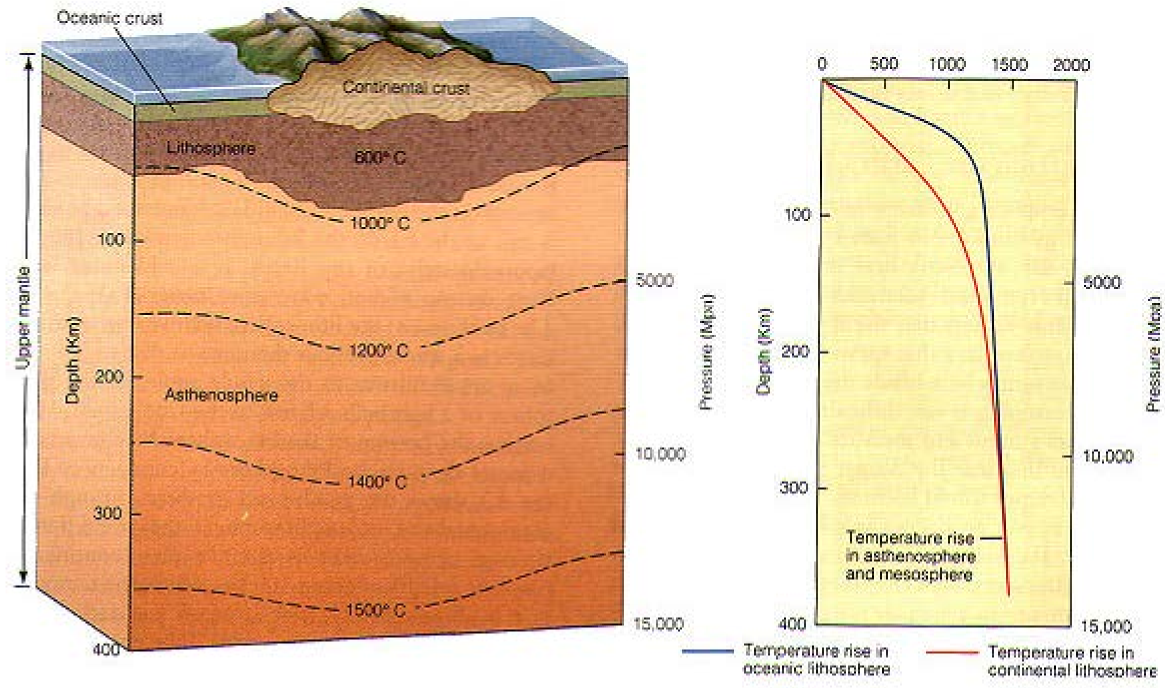
The most important effect of convection current inside the Earth is plate tectonics, the slow, lateral movement of segments of the Earth's hard, outermost shell, the **lithosphere**.

3. The Geothermal Gradient

Careful measurements in mines and drillholes around the world show that the rate of temperature increase with depth (called the geothermal gradient) varies from place to place, ranging from 5°C to 75°C/km. Gradients lessen with depth; below 200 km the gradient is thought to be only 0.5°C/km. By extrapolation, we calculate that the temperature at the centre of the Earth must be at least 5000°C.

Because rock in the lithosphere is too strong and too rigid for **convection** to happen, heat moves through the lithosphere by conduction. **Conduction** is a slow process, so thermal gradients in the lithosphere are steep – that is, temperature changes rapidly with depth. The temperature at the base of the lithosphere – that is, the lithosphere-asthenosphere boundary – varies from about 1300°C beneath the oceans to 1350°C beneath the continents.

To the first approximation the temperature at the top of the lithosphere is 0°C. Because the oceanic lithosphere is 100 km thick, the average geothermal gradient in the oceanic lithosphere is 1300°C/100 km. By contrast, the continental lithosphere is about 200 km thick, so the average geothermal gradient in the continental lithosphere is about 1300°C/200 km.



The geothermal gradient

A : Dashed lines are isotherms. Temperature increases more slowly with depth under the continental crust than under the oceanic crust.
B: The earth's surface is at the top, depth increases downward. Temperature increases from left to right.

BIBLIOGRAPHY:

[i] Skinner, Porter & Botkin, 1999