Hartai Éva,

Geology

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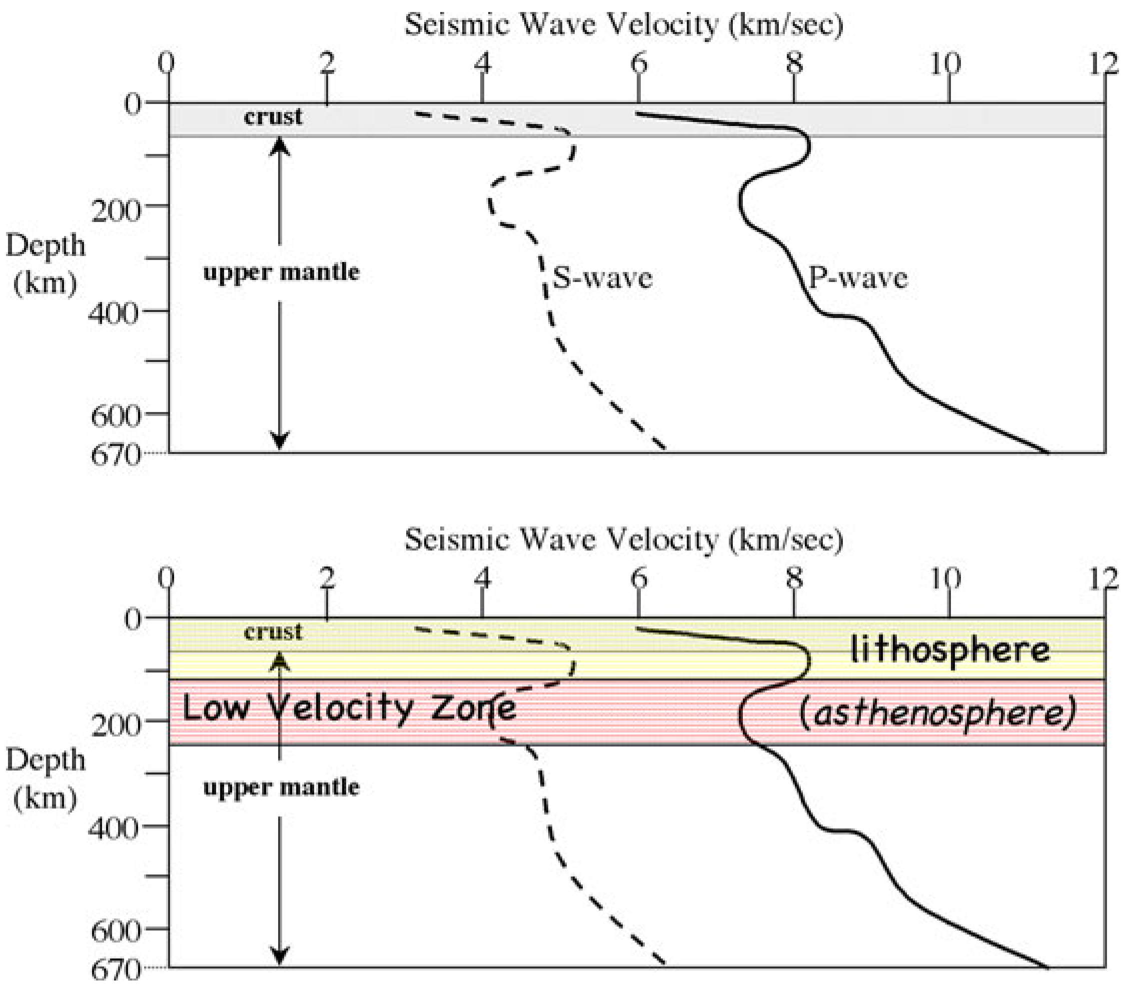
A Műszaki Földtudományi Alapszak tananyagainak kifejlesztése a
TÁMOP 4.1.2-08/1/A-2009-0033 pályázat keretében valósult meg.

VI. The asthenosphere

1. The recognition of the low velocity zone

In the early 1960s, based on seismic measurement a "**low-velocity zone**" was indentified between the depths of 100-350 km. In this interval both longitudinal and transversal waves can pass through the rock but they are slowed down. It means that the rock material in this zone is exceedingly week and has viscous fluid-like properties.

This "weak" rock belt was identified as the **asthenosphere**, a part of the Earth's mantle, which had been postulated many years earlier in order to explain isostasy. At that time the asthenosphere had been interpreted as a plastic zone on which the crust floated. This theory had never been proved and it was realized that the low-velocity zone should be the same.



***The low-velocity zone* [i]**

The transversal (S) and longitudinal (P) waves are slowed down in the asthenosphere.

There was another important discovery, namely that the lithosphere is rigid and strong enough to form coherent slabs (**plates**).

These two points answered the main objection to Wegener' ideas – movement must occur with minimal resistance from friction. The lithosphere is much thicker than the crust, thus as the lithosphere moves, the crust is rafted along as a passenger. It is true that continents move but they do so only as portions of larger plates, not as discrete entities.

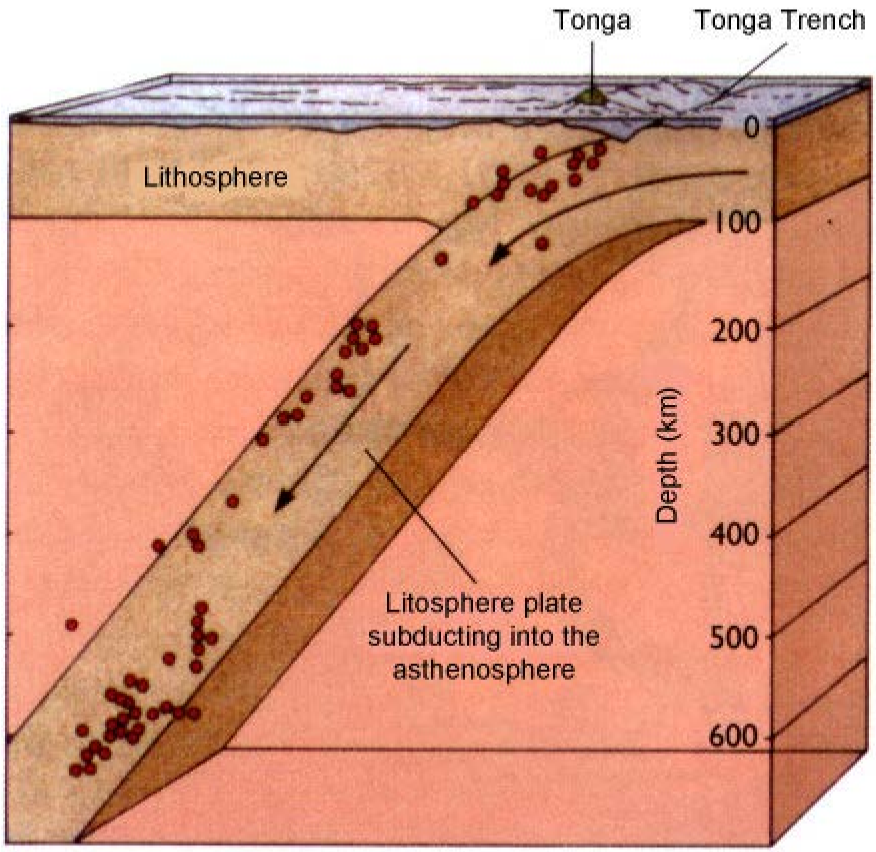
2. The new interpretation of the Benioff zone

As the theory of seafloor spreading was accepted, another question had to be answered. If new oceanic crust is being created along the mid-ocean ridges, either the Earth must be expanding and the ocean basins getting larger, or else an equal amount of old crust must be being destroyed. The answer for the puzzle was provided by the previously unexplained **Benioff zone**.

Shallow focus earthquakes near the deep ocean trenches and in the overriding plate are principally produced by motions on thrust faults, indicating compression (converging plates). A plane of earthquake foci descends beneath the overriding plate. The farther from the trench, the deeper the earthquakes are. This was first recognized by ***Kiyoo Wadati*** in Japan in the 1920s.

***Hugo Benioff* [ii]**
American seismologist, who pointed out the subducting lithosphere plates based on seismic measurements.

Hugo Benioff studied this phenomenon in the 1950s and he proposed that the plane of descending earthquakes was the result of the seafloor subducting beneath the continent. These earthquakes of the **Benioff zone** (or Wadati-Benioff zone) are believed to delineate the upper surface of the descending plate (or slab). Benioff zone earthquakes occur down to depths of around 670 km at some subduction zones but no earthquakes have ever been recorded below the 670 km depth.



The Benioff zone

The earthquake foci define the position of the subducting plate. Earthquakes are generated by the downward movement of the comparatively cold and rigid slab of lithosphere in the weak asthenosphere.Benioff could not explain the causes of the subduction as he did not know anything about the "weak" asthenosphere.

The new interpretation of the phenomenon in the late 1960s pointed out that the Benioff zones are the places where the lithosphere is destroyed. Destruction of old oceanic lithosphere and creation of new oceanic lithosphere are in balance.

BIBLIOGRAPHY:

[i] http://www.csus.edu

[ii] http://photos.aip.org