

The Earth's layers — The Earth is a layered planet consisting of crust, mantle and core (Fig. 1). The outer 100 km or so is a rigid layer called the **lithosphere** that is made up of the crust and uppermost mantle. The lithosphere is broken into a number of large and small plates that move over the **asthenosphere**, a plastic layer in the upper mantle. Earthquakes and volcanoes are concentrated at the boundaries between lithospheric plates. It is thought that plate movement is caused by convection currents in the mantle (Fig. 2), although the exact mechanism is not known. Lithosphere plates are moving at rates of a few cm per year, on average.

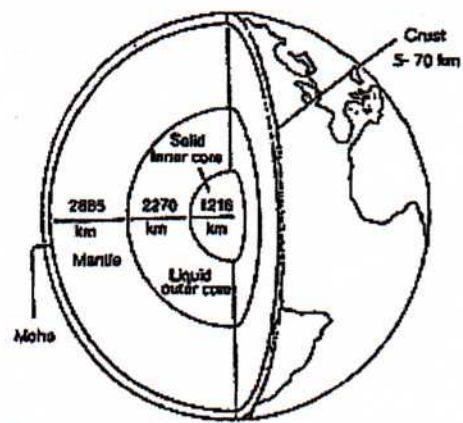


Figure 1. The Earth's layers. The Moho is the boundary between crust and mantle. Modified from NSTA/FEMA (1988).

Types of plate boundaries — There are three types of boundaries between lithospheric plates (Fig. 3):

- 1) **convergent boundary** — plates converge, or come together. If a plate of oceanic lithosphere collides with thicker and less dense continental lithosphere, the denser oceanic plate will dive beneath the continent in a subduction zone (Fig. 2).
- 2) **divergent boundary** — two plates diverge, or move apart and new crust or lithosphere is formed.
- 3) **transform boundary** — plates slide past one another with no creation or destruction of lithosphere.

The Ocean Floor — A map of the ocean floor shows a variety of topographic features: flat plains, long mountain chains, and deep trenches. **Mid-ocean ridges** are part of chain of mountains some 84,000 km long. The Mid-Atlantic Ridge is the longest mountain chain on Earth. These ridges are spreading centers or **divergent boundaries** where the upwelling of magma from the mantle creates new ocean floor. The **rift zone** is the valley between the two ridges where the plates are pulling apart and new material is rising.

Deep-sea trenches are long, narrow basins that extend 8-11 km below sea level. Trenches develop adjacent to subduction zones, where oceanic lithosphere slides back into the mantle (Fig. 2).

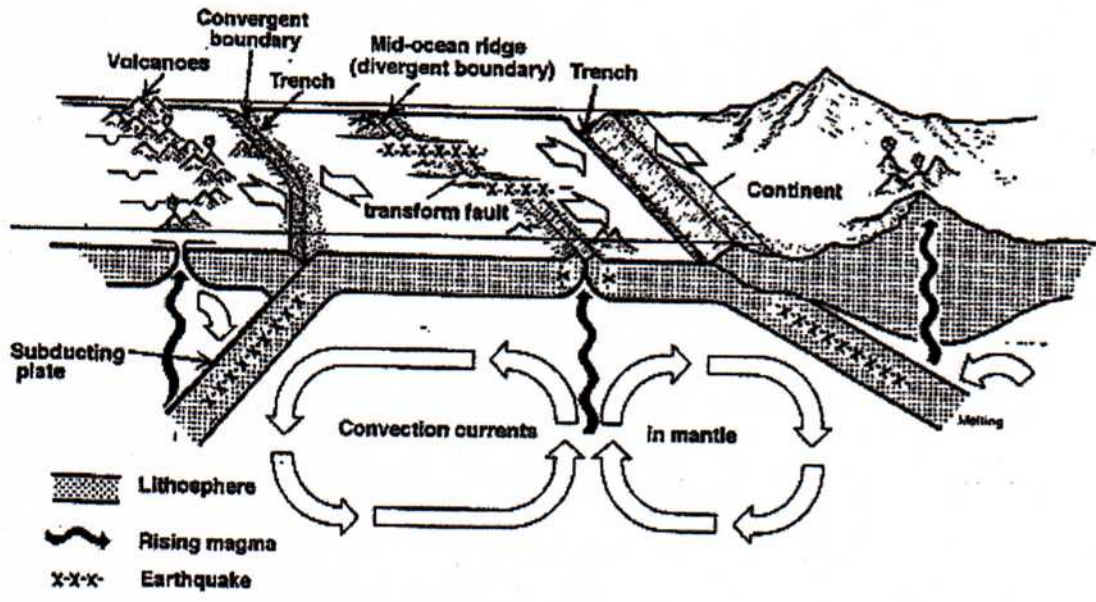


Figure 2. Sea-floor spreading. Modified from NSTA/FEMA (1988).

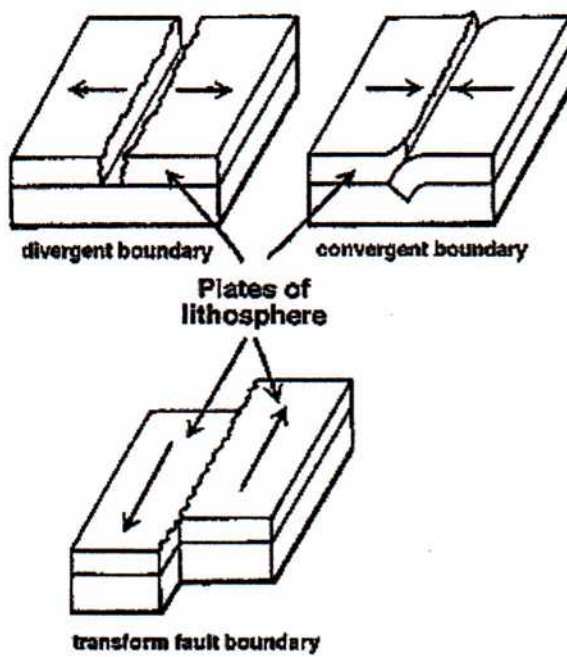


Figure 3. Types of plate boundaries. Modified from NSTA/FEMA(1988).

Continental Drift— The idea that continents move is an old one; Alfred Wegener, a German meteorologist, proposed the hypothesis of **continental drift** in the early 1900's. Wegener used several lines of evidence to support his idea that the continents were once joined together in a supercontinent called **Pangaea** and have since moved away from one another: (1) the similarity in shape of the continents, as if they once fit together like the pieces of a jigsaw puzzle; (2) the presence of fossils such as *Glossopteris*, a fossil fern whose spores could not cross wide oceans, on the now widely-separated continents of Africa, Australia, and India; (3) the presence of glacial deposits on continents now found near the equator; and (4) the similarity of rock sequences on different continents.

Wegener's hypothesis of continental drift was not widely accepted because he had no mechanism to explain how the continents move. Physicists at that time knew the continents could not withstand the pressure of being pushed or pulled *through* oceanic crust. The idea was not revived until new technology made exploration of the ocean floor possible.

Sea-floor spreading — In the early 1960s, Princeton geologist Harry Hess proposed the hypothesis of sea-floor spreading, in which basaltic magma from the mantle rises to create new ocean floor at mid-ocean ridges. On each side of the ridge, sea floor moves from the ridge towards the deep-sea trenches, where it is subducted and recycled back into the mantle (Fig. 2). Without hard evidence for the hypothesis, he called his idea "geo-poetry". A test of the hypothesis of sea-floor spreading was provided by studies of the Earth's magnetism.

