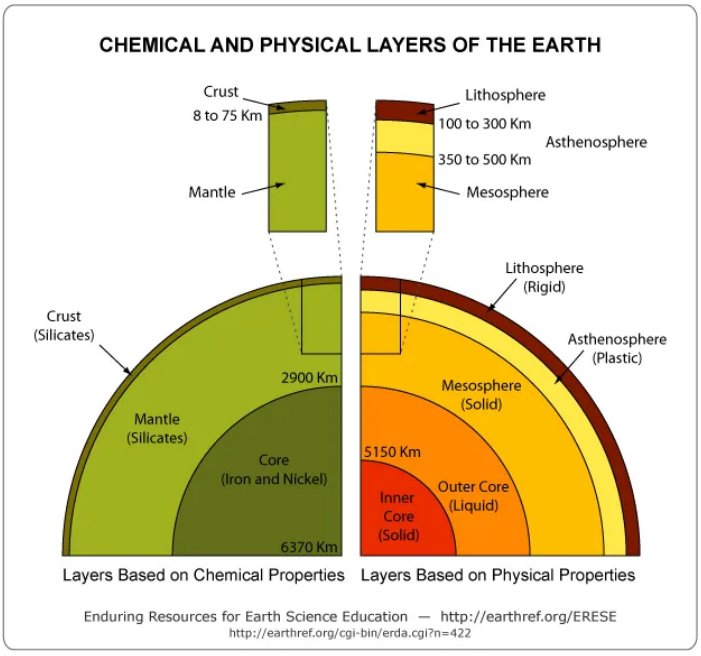
Earth Science Reviewer

The Layers of the Earth and its Composition

The Earth can be subdivided into layers based on two criteria: (1) composition (density) differences and (2) physical properties.



Credit: Enduring Resources for Earth Science Education (ERESE)

I. Based on compositional differences.

1. Crust.

This is the thinnest and outermost layer of the Earth. There are two types of crust– the **continental crust** and the **oceanic crust**.

The continental crust is the older and more buoyant type of crust. It has an average thickness of 35 km, but can be more than 70 km thick in mountainous regions. It has an average composition consisting of granite with a density of 2.7 g/cm^3.

The oceanic crust is the younger and denser type of crust. It has an average thickness of 7 km, much thinner than the continental crust. It is composed of basalt, a dark igneous rock with a density of 3.0 g/cm^3.

2. Mantle.

The mantle comprises the majority of the Earth's volume (more than 80%) and begins where the crust ends, down to a depth of 2,900 km.

The boundary between the crust and mantle is called the **Mohorovičić discontinuity**, which is marked by a change in chemical composition.

It can be divided into two parts: the upper mantle and the lower mantle, separated by the **Repetti discontinuity**.

3. Core.

The core begins at the mantle-core boundary, the **Gutenberg discontinuity**, located at the 2,900 km depth.

Although **no one has ever been to or sampled the core**, scientific investigations led to the conclusion that its composition is made up of a Fe-Ni (iron and nickel) alloy.

Due to its composition and the pressure conditions at depth, it is calculated to have a whopping density of around 11 g/cm^3.

II. Based on physical properties.

1. Lithosphere.

The lithosphere (from the Greek word *lithos* meaning “stone”) is a thick and brittle layer that comprises the entire crust and uppermost layer of the upper mantle.
It has an average thickness of 100 km but can reach up to 300 km in the thickest portions of continents.

2. Asthenosphere.

The asthenosphere (from the Greek word *asthenēs* meaning “weak”) is a mechanically weak layer consisting of the lower portion of the upper mantle, extending down to 660 km.

Contrary to popular belief, it is not a “sea of molten rock”. The upper mantle is actually composed of an Mg- and Fe-rich rock called **peridotite**.

At this depth, the temperature and pressure conditions are high enough that rocks become ductile and deform easily. Because of this, the asthenosphere flows more like very, *very* viscous fluid (but remember: it is *not* liquid!) and moves independently from the overlying lithosphere. This is a very important mechanism for plate tectonics (which will be discussed later in more detail).

3. Mesosphere.

Beneath the asthenosphere is the mesosphere (from the Greek word *mesos* meaning “middle”), made up of the lower mantle, and reaches down to the 2,900 km depth.

The dominant rock type in this layer is a silicate rock called **perovskite**.

4. Outer core.

Unlike all the other mechanical layers, **the outer core is the only one made out of liquid**—melted Fe-Ni alloy, to be exact.

The liquid nature of this layer can be attributed to extremely high temperatures (more than 3000°C!) that melt Fe, Ni, and all other elements.

The flow of the liquid metals is responsible for the Earth's magnetic field. The outer core terminates at a depth of 5,150 km, where the solid inner core begins. The outer-inner core boundary is also known as the **Lehmann discontinuity**.

5. Inner core.

Despite the extreme temperature, the overwhelming pressure in this layer forces the inner core to be a **solid ball of mostly Fe**.

Temperatures in the inner core are **similar to the temperatures of the surface of the Sun**—around more than 5400°C.