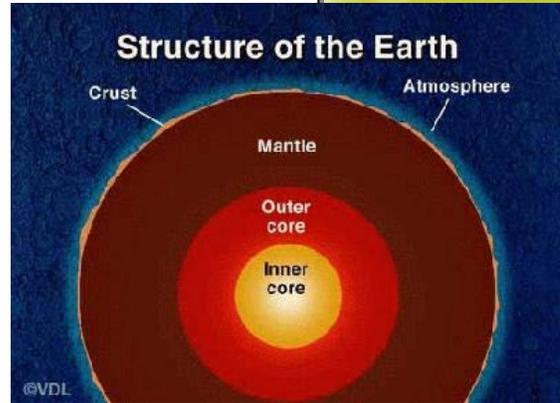


Geologists are scientists who study the history, composition, and land formations of Earth. Some geologists are interested in learning more about the interior, or inside, of Earth. Geologists use data from many sources in their work. For example, they create and study maps of geologic formations, examine areas where molten rock from inside Earth reaches the surface, consider how Earth's magnetic field works, and analyze data from earthquake waves that move through the planet.



This diagram shows the four major layers of Earth.

Geologists now know that Earth is composed of four main layers. The crust is the outermost layer and is composed of solid rock. The mantle lies below the crust and is composed of hot, moving rock material. The outer core lies below the mantle and consists of hot, liquid metals. The inner core is the innermost layer and is composed of hot solid metals under intense pressure.

## The Crust

The crust is the outermost, rocky layer of Earth. Compared with the size of the planet and the thickness of the other layers, the crust is very thin. If Earth were an apple, the crust would only be as thick as its skin. It is 5 to 10 kilometers thick under the oceans, and about 15 to 80 kilometers thick under the continents.

Compared with the rock in the mantle, the rock that makes up the crust is also much lighter. It floats on the denser mantle in big pieces, or plates. Where plates meet, their edges push into or pull apart from one another. This causes pressure to build, and earthquakes tend to occur in these areas. Also, the crust is not completely solid in these areas. This allows magma from



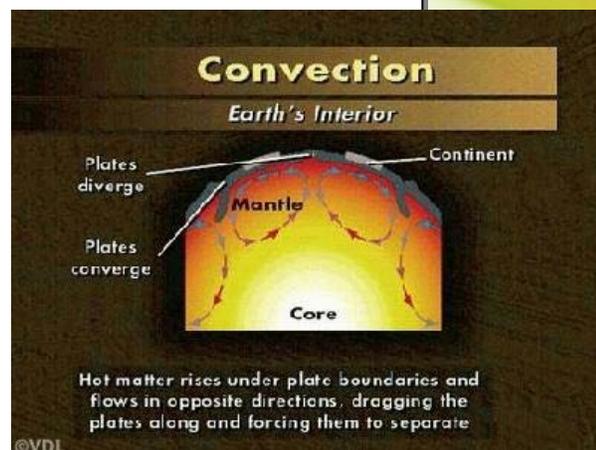
The crust is broken into large pieces, or plates. The plates float on the mantle. The pink lines on this map show where the plate boundaries occur.

the upper mantle to more easily find its way to the surface. Volcanoes are often located along plate boundaries.

## The Mantle

The mantle is a layer of material that is 2,900 kilometers thick and found between the crust and the core. This material is rock that is near its melting point, and it can deform, or change shape. Temperatures in the mantle can vary depending on the distance to the core. Temperatures near the crust are around 870 °C. The part of the mantle next to the core is much hotter. Temperatures here can reach 2,200 °C. The mantle also has two different layers: the upper mantle and the lower mantle. The upper mantle is partially molten and can be found from 5 to 50 kilometers below the crust. The lower mantle flows slowly like liquid due to the amount of pressure and heat, and is located at a depth of about 650 to 3,000 kilometers.

Because of its great depth, direct observations of the mantle have not been possible. However, geologists have found other ways to study the composition of the mantle. One way they do this is by studying lava. Lava, or magma that reaches the surface, helps geologists understand what makes up the mantle. Geologists also look at data from earthquakes to help them understand more about Earth's interior. Earthquakes create waves in Earth's material, including primary compression (or "P") waves and slower secondary shear (or "S") waves. Compression waves travel through both solid and liquid materials, but shear waves cannot travel through liquids. Also, the speeds of earthquake waves are faster in solids and slower in liquids. Earthquake waves can travel through the planet and be detected on the other side. Data from studying these waves has helped geologists figure out the sizes of the different regions inside Earth, as well as which are solid and which are liquid.



Convection currents in the mantle cause the plates of Earth's crust to move constantly.

The rocky material of the mantle is heated by the energy coming from the inner core. This causes it to move in slow convection currents. Material close to the core becomes hot and flows away from the core toward the crust. As it rises and moves away from the heat source, the material cools. Cooler material sinks. As it sinks back down toward the core, it is heated and rises again. This cycle repeats again and again, but slowly. One full cycle takes millions of years. The movement of hot rock in the mantle causes the plates of the crust, which float on it, to also move.

### **The Outer Core and Inner Core**

Earth's outer core lies directly below the mantle and is about 2,250 kilometers thick. It is made of hot, liquid nickel and iron. Temperatures here can range from 2,200 °C to 5,000 °C. These high temperatures keep the metals in a liquid state.

The inner core lies within the outer core and is at the center of Earth. The inner core is a ball with a radius of about 1,220 kilometers, and it has a temperature of about 5,430 °C—almost as hot as the surface of the Sun. It is also made of nickel and iron, as well as heavy metals such as gold and platinum. However, although the temperature of the inner core is well beyond its materials' melting points, the intense pressure at the center of the Earth forces them to remain solid.

Sometimes scientists cannot directly observe the things they study, so they need to examine other data that can help them figure out what they want to know. We know a lot about Earth's interior without ever having seen it.