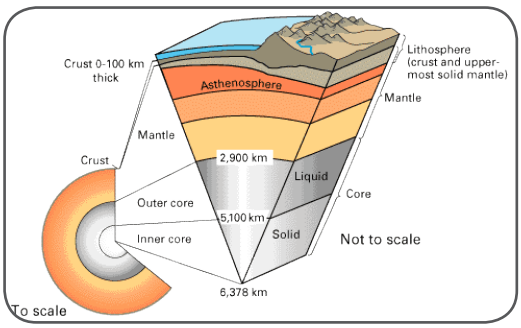
Getting to Know: Physical Properties of Earth's Layers

People are often surprised to learn that the planet we live on is not a solid mass. In fact, large areas of Earth's interior are liquid or contain slowly flowing semisolid rock material. People are also surprised to learn that Earth's core is made of solid metal. Both of these facts are based on studies of Earth's layers.

Earth's interior can be divided into layers based on physical characteristics or by composition. Compositional characteristics describe the materials that make up the rock layer. Physical characteristics include whether the layer is solid or liquid.



Earth's layers can be divided by their composition or by their physical characteristics. (Image from the US Geological Survey)

What are the compositional layers of Earth?

The *compositional layers* of Earth are the crust, mantle, outer core, and inner core. The *crust* is the outermost layer of Earth—it is the only layer that we can see. It is silica-rich and contains both oceanic crust and continental crust. Oceanic crust contains relatively dense rocks like basalt, whereas continental crust contains less dense rock such as granite.

The crust rests on the mantle. The *mantle* comprises most of Earth's volume and differs in composition from the crust. Mantle rock contains heavier elements such as magnesium and iron, which make the mantle much denser than the crust. The mantle surrounds Earth's *core*, which is made of very dense metals such as iron and nickel.

What are the physical layers of Earth?

The *physical layers* of Earth are the lithosphere, asthenosphere, mesosphere, outer core, and inner core. The *lithosphere* is the outer layer of solid rock that is found at Earth's surface. It includes both the crust and the solid, uppermost part of the mantle. The lithosphere is relatively less dense than Earth's other physical layers. The *asthenosphere* is found below the lithosphere and rocks that make up the asthenosphere are semisolid—they flow slowly like warm putty. The *mesosphere* is a solid layer below the asthenosphere. The mesosphere is much denser than the asthenosphere. The *outer core* is a liquid layer beneath the mesosphere. Finally, the *inner core* is the solid center of the Earth.

How do characteristics of the asthenosphere affect Earth's surface?

The asthenosphere is not a liquid. Rock material that makes up the asthenosphere is *ductile,* meaning that it can be stretched slowly, like taffy. The asthenosphere is ductile because of the intense heat of Earth's interior.

Misconception 1: ***The lithosphere and asthenosphere are another way of describing the crust and mantle.***

The crust and mantle are compositional layers of Earth. The lithosphere and asthenosphere are physical layers. The lithosphere includes the crust and the solid, outermost part of the mantle. The crust is thinner than the lithosphere and contains rock material that is rich in silica and is much less dense than the rock material in Earth's other layers. The asthenosphere is a semisolid layer between the solid lithosphere and mesosphere.

As rock material in the lower portion of the asthenosphere is heated, it rises slowly. As it rises, it begins to cool and sinks again. Thus, rock material in the asthenosphere circulates in enormous convection cells. These convection cells cause tectonic plate movement. Lithospheric plates, which rest on the asthenosphere, are carried along as the asthenosphere slowly flows. The movement of lithospheric plates causes earthquakes and volcanoes.

How do scientists know there are different physical layers of Earth?

The study of earthquakes helps scientists learn about Earth's physical layers. The seismic waves released by an earthquake spread throughout Earth in all directions, and subtle changes in the speed or direction of these waves indicate differences in the physical structure of Earth's interior.

In fact, studies of earthquake waves helped scientists discover that Earth's outer core is liquid. Earthquakes release two types of waves: P waves and S waves. P waves can travel through solids and liquids, but S waves cannot travel through liquids. When scientists observed that S waves do not travel through Earth's core, they realized that the outer core is liquid.

Earthquakes result from the movement of lithospheric plates on top of the asthenosphere.

Misconception 2: ***Why can't scientists study Earth's core by drilling into it or by studying the composition of magma?***

Temperatures and pressures in Earth's interior are too great for a drill bit to withstand. Also, Earth's core is more than 6,000 km below the crust. Studying magma does not help scientists learn about the Earth's core either. Magma forms from rock material in Earth's crust or in the uppermost part of the mantle. Its composition is very different from the composition of Earth's core.