

Getting to Know: Structure Based on Composition

Have you ever dug a hole in the ground and wondered what you would discover if you kept digging deeper and deeper? Scientists are also curious about Earth's interior. Because it is impossible to drill very deep into Earth's layers, scientists must rely on indirect evidence to learn about Earth's structure. One way scientists learn about Earth's interior is by analyzing the composition of lava from volcanoes.

A *volcanologist* is a specialized scientist who studies the formation and composition of lava.

Scientists know the interior of Earth has four distinct compositional layers. A *compositional layer* is one that varies by density and chemical composition. The main compositional layers of Earth are the crust, mantle, outer core, and inner core. Each compositional layer may be a part of another type of classification known as the physical layers of Earth.



Volcanologists get a glimpse into the interior composition of Earth while studying volcanic eruptions. (Image from US Geological Survey)

What are the characteristics of the crust?

The *crust* is the outermost layer of Earth. The crust is very thin, making up only approximately 1% of the overall thickness of Earth. The crust contains rocks and minerals necessary to form soils. Oil deposits, coal, and groundwater resources come from the crust of Earth. The crust is sometimes mistakenly called the lithosphere of Earth, but the lithosphere is actually a physical layer, and the crust is only part of it. Crustal thickness varies from 5 km on the ocean floor to over 100 km in the middle of a range of mountains.



Misconception 1: *The crust and lithosphere are the same structures.*

The lithosphere is a solid layer of the Earth that includes the oceanic crust and the continental crust as well as a thin, solid upper portion of the mantle. The crust is the outermost compositional layer of Earth above the mantle.

What are the characteristics of the mantle?

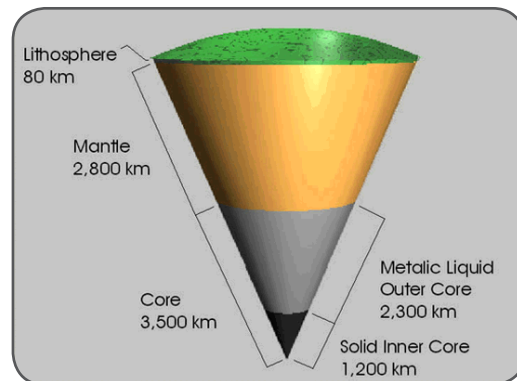
The *mantle* is the largest layer of Earth. The mantle is divided into the upper and lower mantles. The upper mantle is partially molten. Intense pressure inside Earth causes solid material in the mantle to move like a fluid. *Convection* in the mantle causes warm material to rise to the surface and cool. This convection is what causes the movement of tectonic plates along Earth's surface. Scientists hope to drill to the mantle to take direct samples someday. Drilling has already been attempted at the bottom of the ocean where the crust is thinner than the continental crust.

The *asthenosphere* of Earth is the portion of the upper mantle under such intense heat and pressure that it flows like a liquid. Below the asthenosphere is the remainder of the mantle. In physical terms, the remainder of the mantle is called the *mesosphere*, which is solid.

What are the characteristics of the core?

The *core* of Earth is divided into the outer core and inner core. The *outer core* is made of liquid iron and nickel. During the formation of Earth, these elements were very heavy and sank to the interior of the planet. The intense heat and pressure cause the outer core to be liquid. The rotation of Earth on its axis causes the liquid outer core to spin. Earth's magnetic field is generated by this movement.

The *inner core* is solid iron and nickel. The temperature of both the inner and outer cores is similar at roughly 5000°C. The reason for the difference in phase is the intense pressure. Even with similar temperatures, the inner core is solid because it is under more pressure.



The relative thicknesses of the compositional layers of Earth are shown for comparison. (Image from US Geological Survey)

Can scientists be sure the Earth is divided into layers?

Indirect evidence of the composition of Earth's interior comes from a vast amount of geologic data. This evidence includes the analysis of volcanic rocks, studies of earthquake waves, and observations of Earth's magnetic field. Indirect evidence is no less valuable than direct evidence. Scientists must simply devise other testing methods to prove or disprove hypotheses. In the case of Earth's interior, the scientific community universally supports a layered compositional structure.



Misconception 2: *The center of Earth is a hollow sphere.*

Intense pressure from the thousands of kilometers of matter in the core, mantle, and crust would make a hollow earth core impossible. The core of Earth is a solid sphere of iron and nickel.