Module 3: Geology
Topic 1 Content: Earth's Structure Notes

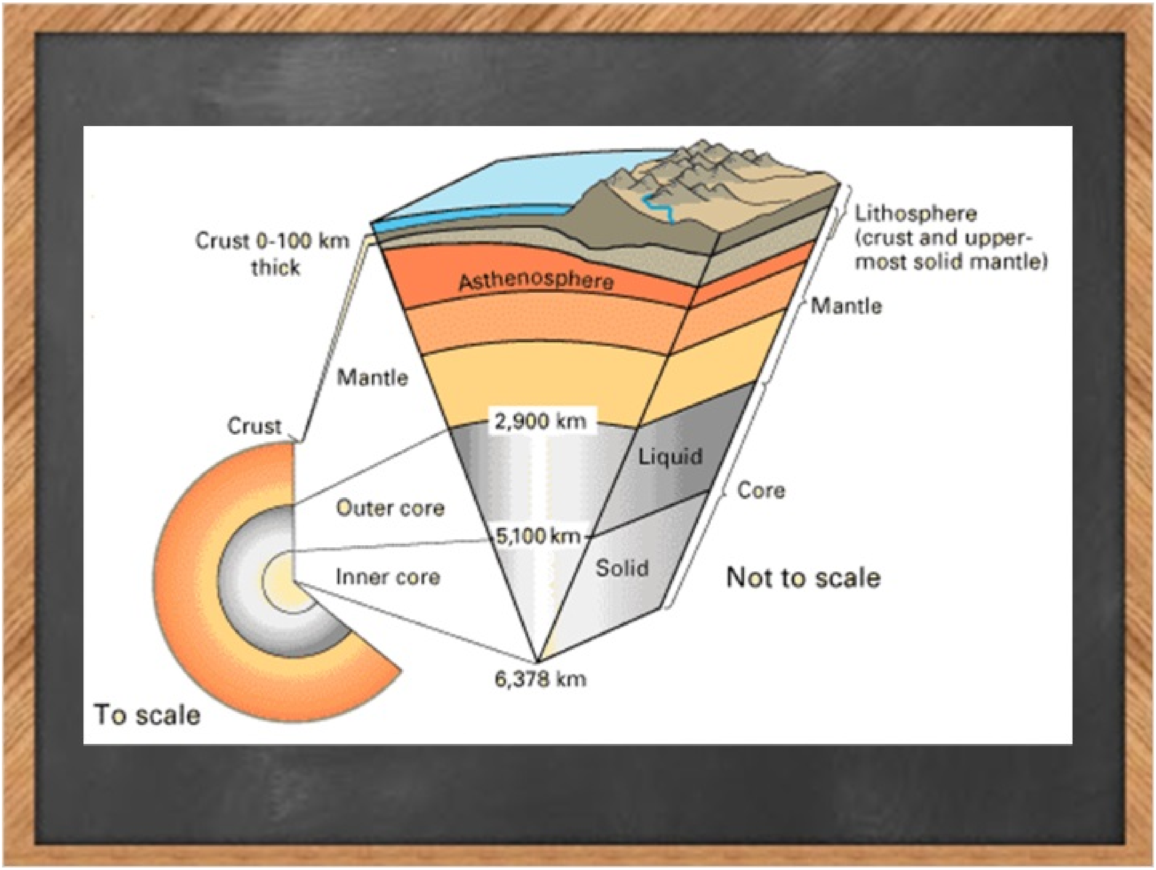
Imagine traveling to the center of the Earth. What conditions would exist? How would you get there? In 1874, author Jules Verne wrote his famous science fiction novel, *A Journey to the Center of the Earth, in which he depicted just such a dangerous and* fanciful journey. More recently, the 2003 film, *The Core, showed moviegoers a much* different take on the mysteries that lay deep within our planet. So, what exactly is the Earth's structure like, and what materials make up our planet? Let's take a closer look in this lesson.

Image credit:

Journey book cover: n/a: Public Domain

Illustration: Édouard Riou: Public Domain

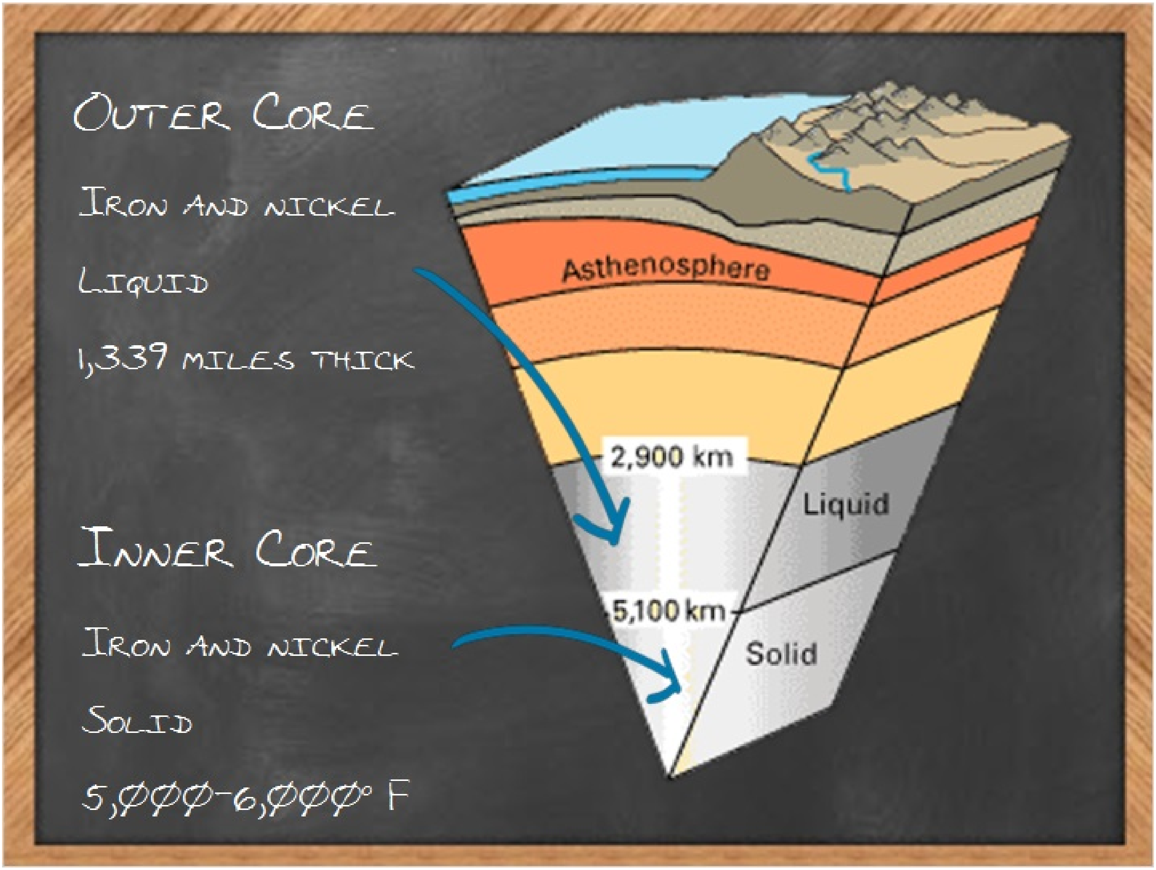
Module 3: Geology
Topic 1 Content: Earth's Structure Notes



To begin, the Earth is made of four main layers: inner core, outer core, mantle, and crust. Unfortunately, scientists don't yet have the technology to travel to the center of the Earth themselves; instead, they gain knowledge of each layer by studying the seismic waves, or vibrations, created by earthquakes. These seismic waves bend and vary their speed based on the unique properties of the layers through which they travel. Geologists interpret these seismic waves to help them estimate the composition and approximate thickness of each layer in the Earth's interior.

Image credit: USGS: Public Domain

Module 3: Geology
Topic 1 Content: Earth's Structure Notes

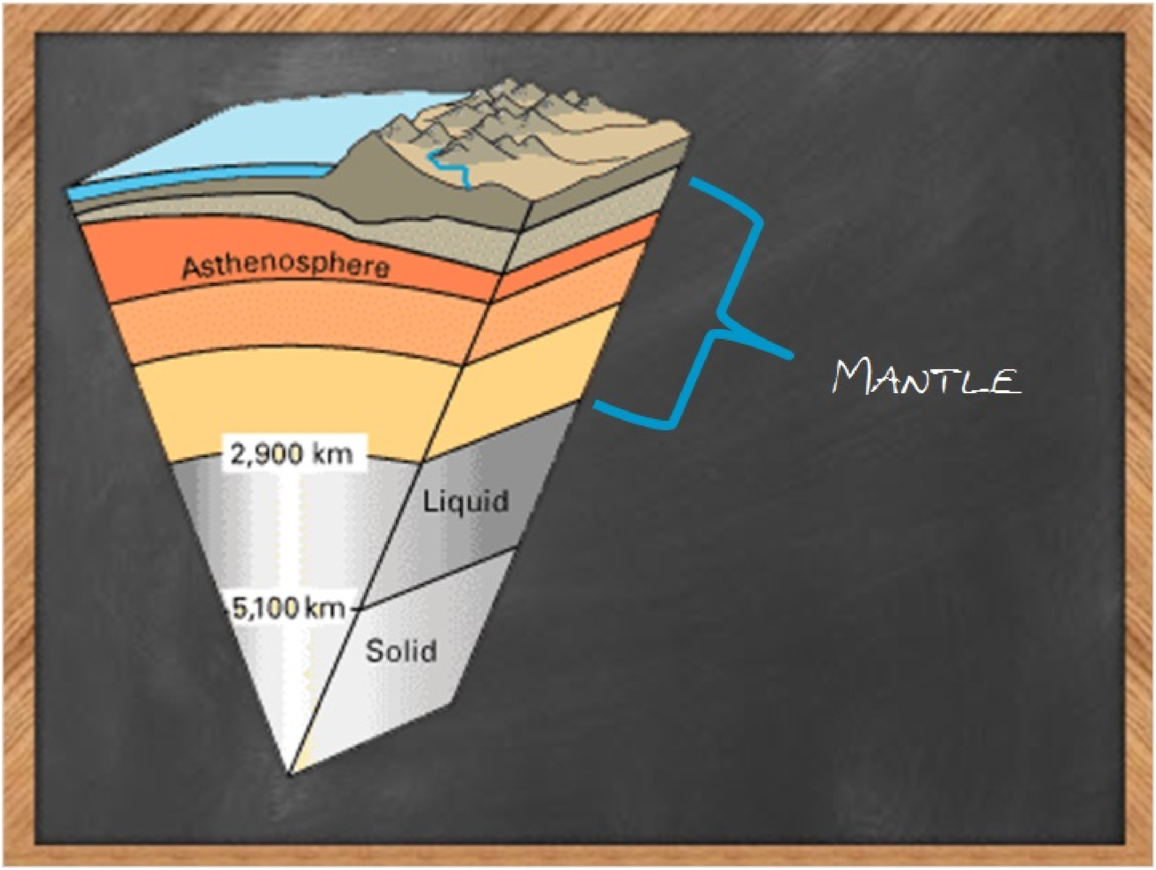


How far away is the center of the Earth? Well, if we could free fall to the center, it would take almost a full day! That's a long way to go! Let's start our journey in the center and learn about each layer as we work our way back up to the surface.

At the Earth's center, you would notice two distinctly different layers: a solid inner core and a liquid outer core. Iron and nickel (and possibly a few other heavy metals) comprise the solid inner core, shown here as the light grey layer. Extreme pressure on the inner core makes this the densest layer and raises its temperature to 5,000-6,000 degrees Fahrenheit – about the same temperature as the surface of the Sun. The inner core is around 800 miles thick. Iron and nickel also comprise the outer core, shown here as the dark grey layer. Although this layer is still very hot, geologists believe the outer core is in a liquid state since it experiences less pressure than the inner core. The outer core is the second largest layer with a thickness of around 1,339 miles.

Image credit: USGS: Public Domain

Module 3: Geology
Topic 1 Content: Earth's Structure Notes

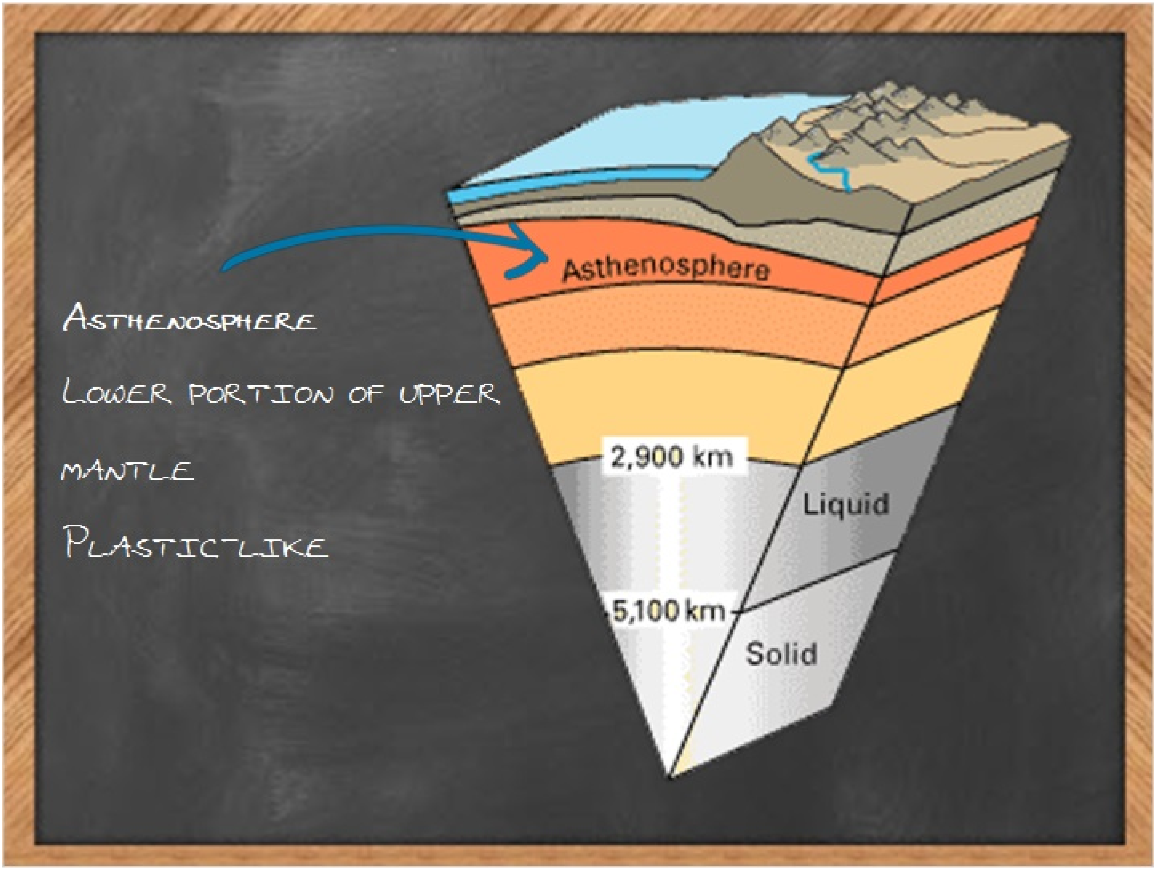


Moving upward from the core, we enter the largest layer, called the mantle. The mantle layer is very different from the core in that it is composed of silicon and oxygen, with some magnesium and iron. The mantle is about 1,793 miles thick. The mantle layer is so large that geologists divide it into a lower portion and an upper portion based on the different characteristics of each portion. In this lesson, we'll focus on two sections within the upper portion.

Image credit: USGS: Public Domain

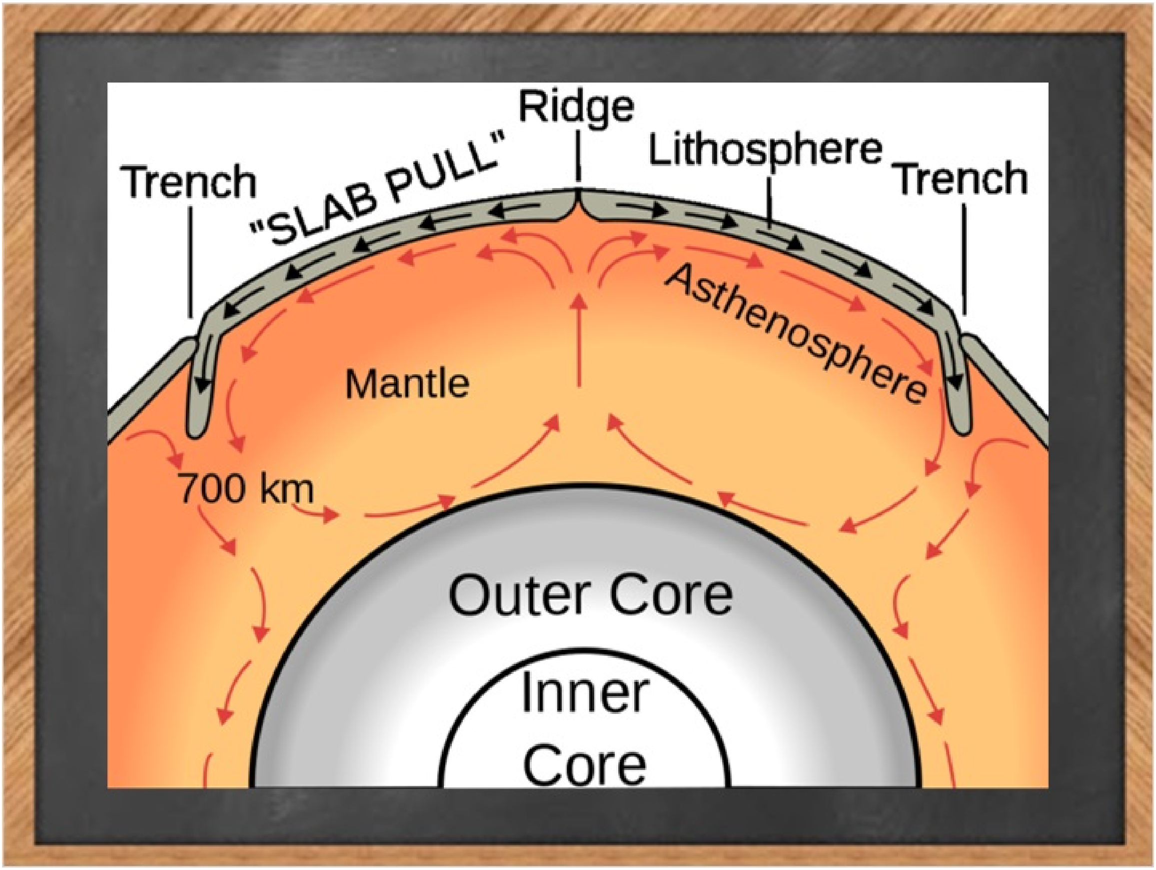
whro EDUCATION

Module 3: Geology
Topic 1 Content: Earth's Structure Notes



The bottom section of the mantle's upper portion is the asthenosphere, shown here as the dark orange layer. Heat escaping from the core keeps the mantle somewhat fluid and moving. Geologists describe the asthenosphere layer as "plastic-like", meaning it moves similar to the way that melted plastic would move.

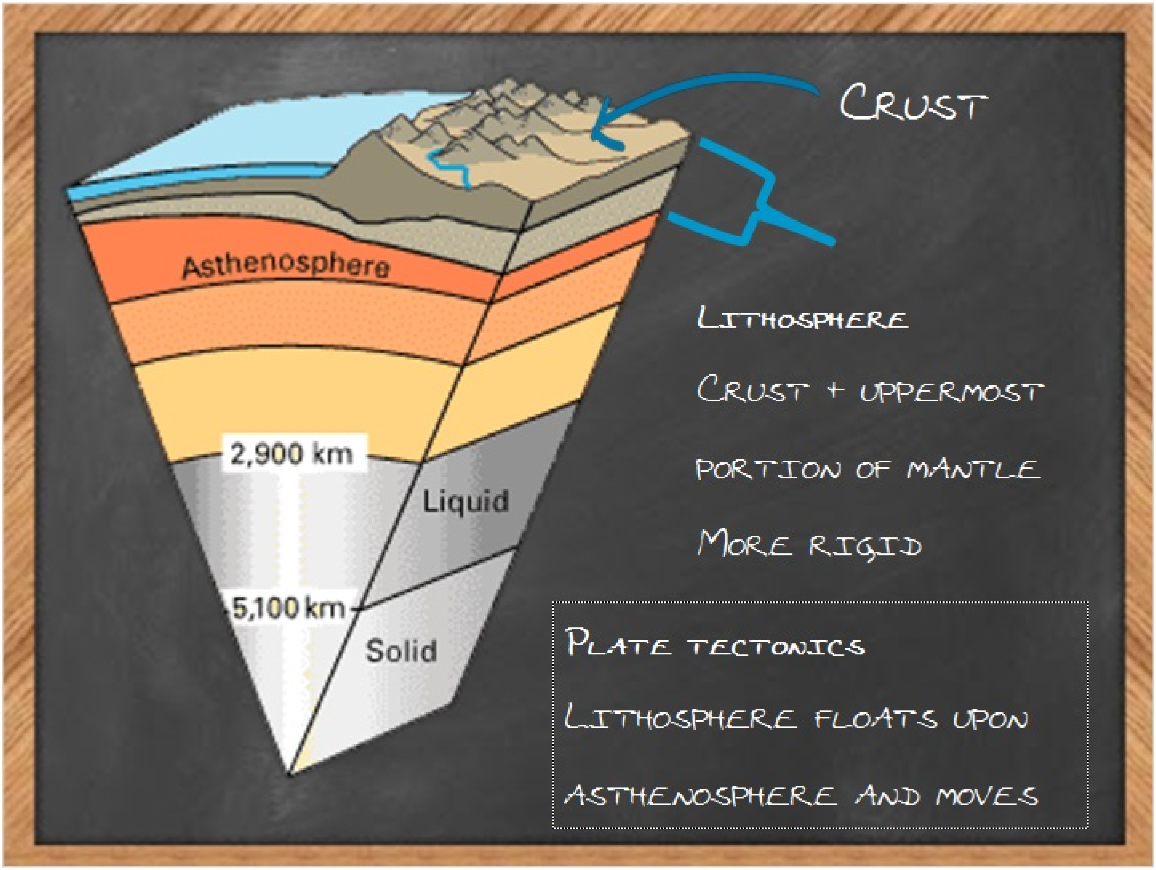
Image credit: USGS: Public Domain



As shown by the red arrows in this illustration, the circular transfer of heat in the mantle moves the upper layers. Scientists call this heat transfer process, thermal convection.

Image credit: USGS: Public Domain

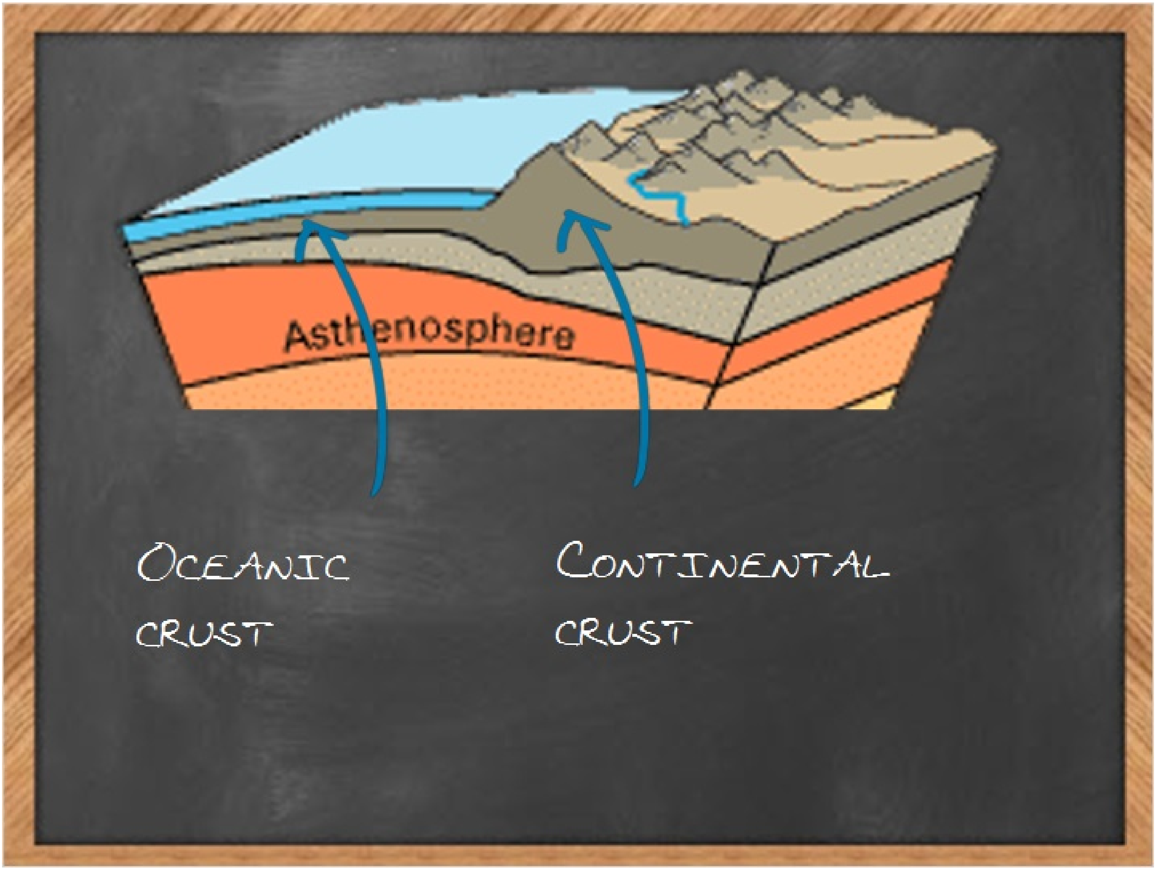
Module 3: Geology
Topic 1 Content: Earth’s Structure Notes



The top section of the upper mantle is more rigid and connects with the final outer shell called the crust. Together, these connected layers are the lithosphere, shown here as the light and dark brown layers. The lithosphere tends to float and move about on the asthenosphere below. Geologists call such movement, plate tectonics, something we'll learn about later in this module.

Image credit: USGS: Public Domain

Module 3: Geology
Topic 1 Content: Earth's Structure Notes

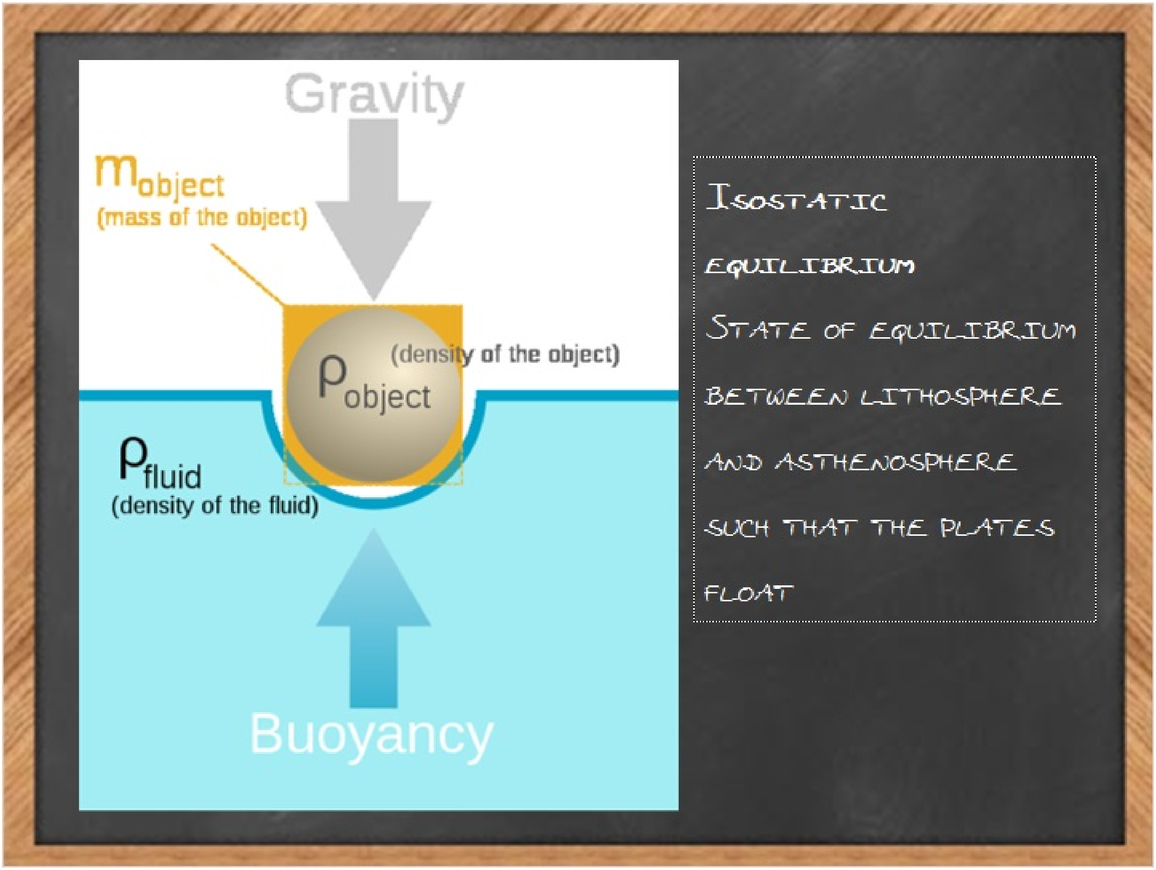


Finally! After a very long journey, we've reached the outer layer, or crust, of the Earth. Imagine that the crust is like the thin and brittle shell of a hardboiled egg with many cracks along its surface. The crust is made of oxygen, silicon, magnesium, aluminum, and iron.

There are two types of crust based on how and where it forms: oceanic and continental. Oceanic crust is thin and made mostly of the rock called basalt**.** As its name implies, oceanic crust exists under the oceans. Continental crust is thick and made mostly of the rock called granite. Continental crust forms the landmass on which we live.

Oceanic crust is slightly denser than continental crust. Whereas the average density of oceanic crust is 2.9 grams per cubic centimeter, the average density of continental crust is 2.8 grams per cubic centimeter.

Image credit: USGS: Public Domain



We must examine one more important principal in this topic. Have you ever marveled at the size of some cargo ships as they slowly sail by in the ocean? Why don't these huge ships sink or tip over?

According to Archimedes' Principle, adding mass to an object causes it to sink deeper into the water, whereas removing mass causes the object to float higher. This is why, when empty, a huge cargo ship rises high up out of the water, but when loaded with hundreds of containers, it's much lower. Cargo loaders must be careful to balance the right amount of cargo on the ship – too much weight and the ship may sink; too little weight and it may become unstable.

Just as a heavy cargo ship floats on the ocean's surface, the Earth's crust floats on the mantle. Like a ship, a balance must exist between the weight of the crust pushing down and the buoyancy of the mantle pushing up.

Recall the two types of crust: oceanic and continental. The denser oceanic crust sinks lower into the mantle than the continental crust, which has less density. Remember this concept when you learn about subduction zones and trenches later in this module.

The plates that form the Earth's crust are in a state of isostatic equilibrium. Much like the stability of a properly loaded cargo vessel on the ocean, the Earth's lithosphere and asthenosphere exist in a highly balanced state; in other words, the plates float, and only major disruptions like earthquakes can disrupt this balance.

Image credit: Yupi666: Creative Commons 3.0