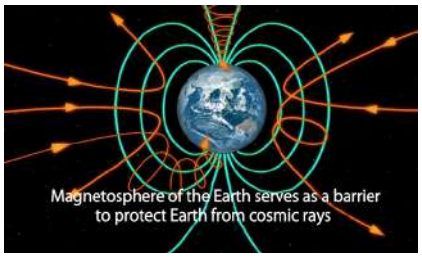
8.3 Layers of the Earth Reading

Words of the Day

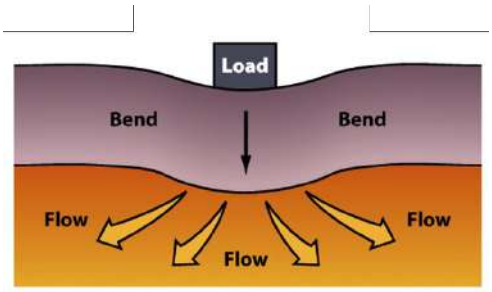
Differentiated: Separating into layers based on density.

Magnetosphere: Created by the convection of the liquid OUTER CORE. Protects the surface of the earth from the sun's harmful solar winds.



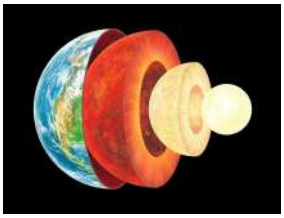
Rigid: Describes solids that break under stress and do not move and bend easily. Includes the crust and lithosphere.

Plastic: Describes solids that will move or flow under stress. Includes the asthenosphere and mantle.



Separation into layers

Like all inner rocky planets, the Earth's interior is **differentiated.** Differentiated means that Earth's internal structure is separated into layers, arranged like the skin of an onion. Peel back one layer, and you find another. Earth's layers are separated using both composition and mechanical categories. *See Figure 1 below*



These layers formed when the building blocks of Earth, known as planetesimals, collided and collapsed under their own gravity around 4.5 billion years ago. After several million years, the Earth separated into several layers. Iron, nickel and other heavy metals mostly settled to the core; lighter elements remained in the mantle around the core. The lightest elements, such as oxygen and silicon, floated to the top and cooled, forming a solid crust.

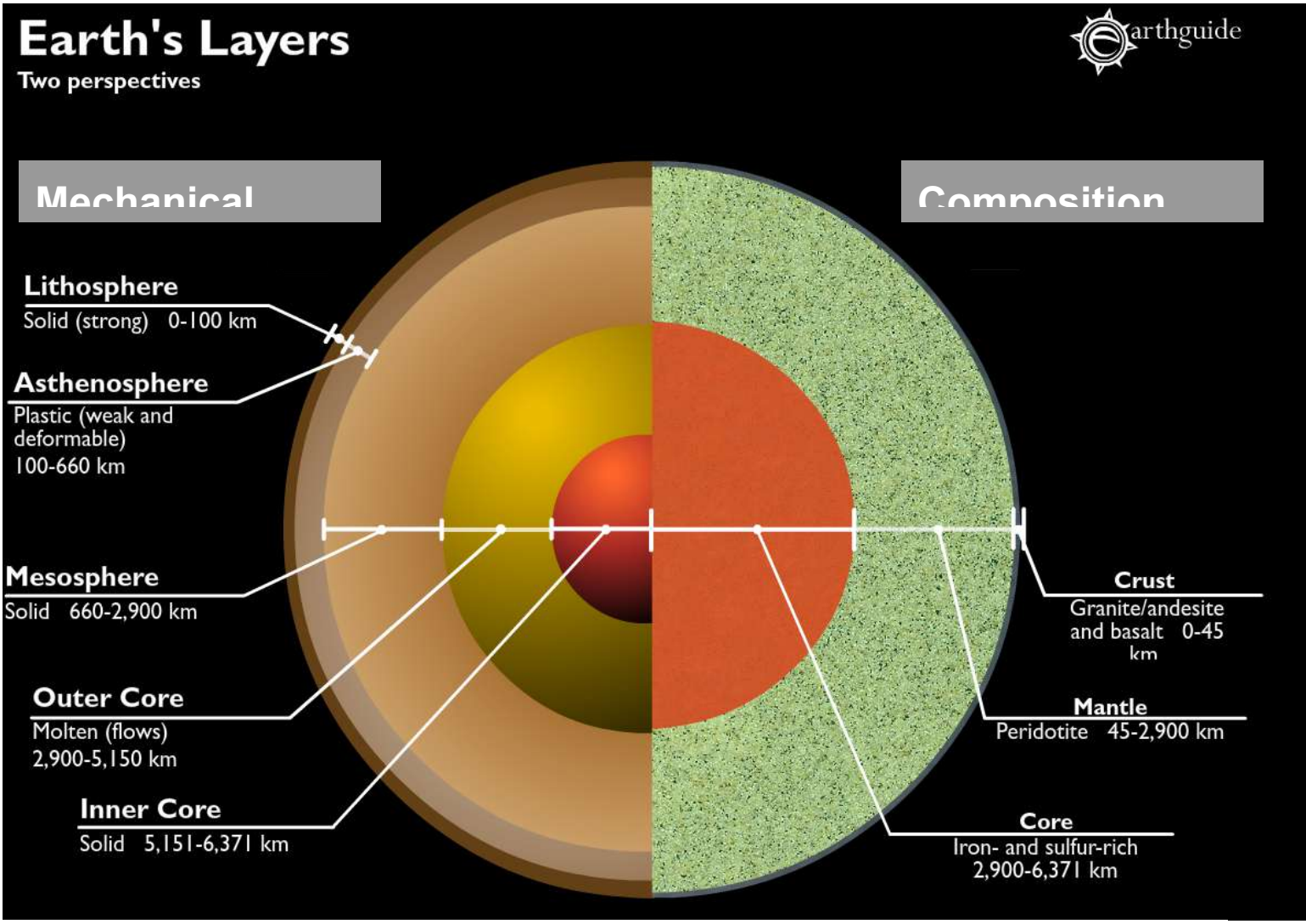


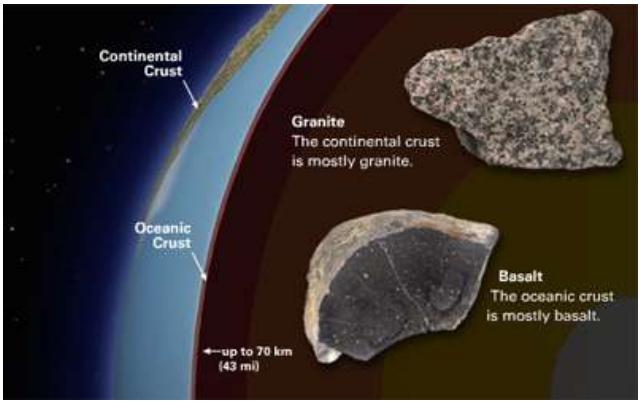
Figure 1: Earth's Mechanical and Composition Layers

Layers based on composition

The composition layers are based on what elements are found in each layer. During Earth's early formation, the planet underwent a period of **differentiation** that allowed the heaviest, most dense

elements to sink to the center and lighter, less dense elements to rise to the surface. Earth's internal layering can be defined by this resulting chemical composition and density differences. The three main layers of Earth defined by composition include the crust (1 percent of Earth's volume), the mantle (84 percent), and the core (inner and outer combined, 15 percent).

Crust



The solid **crust** is the outermost and thinnest layer of our planet. The crust averages 45 kilometers in thickness. The crust is broken up between the continental and oceanic crust. Continental crust is thickest at the Himalayan mountains at about 70 km thick and is made mostly of the rock granite. Oceanic crust is the thinnest part of the crust (10 km) and is made of basalt.

The most abundant elements in the Earth's crust include oxygen (O), silicon (Si), aluminum (Al), iron (Fe), and calcium (Ca). These elements combine to form the most abundant minerals in the Earth's crust called silicates.

Mantle

The **mantle** is the layer found between the crust and the core. The mantle is hot (932 to 1,652 degrees Fahrenheit, 500 to 900 degrees Celsius) and denser then the crust The mantle is the thickest layer with a depth between 45-2,900 km. The mantle is composed of silicate minerals that are similar to ones found in the crust, except with more magnesium (Mg) and iron (Fe) and less silicon (Si) and aluminum (Al). The mantle is made of a light green rock called peridotite.

Core

At the planet's center lies a dense metallic **core**. Calculations indicate that the core is about 85 percent iron (Fe) with nickel (Ni) metal making up much of the remaining 15 percent of Earth's volume. It has a depth between 2,900-6,371 km. The core is not completely solid however the solid part of the core is thought to be metal Iron and Nickel similar to metallic meteorites.

Layers based on mechanical properties

The Earth is separated into layers based on mechanical properties in addition to the composition layers described above. Mechanical properties include the state of matter and how the matter moves

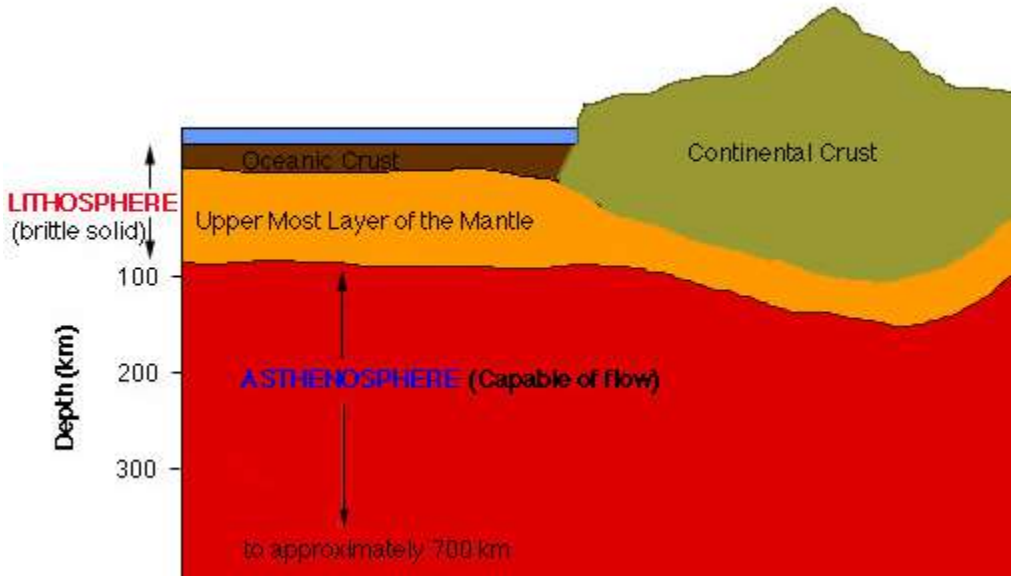
and behaves. Mechanical properties change because of the increase in temperatures and pressure inside the Earth.

Lithosphere

The **lithosphere** is the solid, outermost layer that includes the crust and the brittle upper portion of the mantle. This rigid layer is about 100 km thick. The lithosphere is divided into 15 major tectonic plates, and it is at the boundary of these plates where earthquakes and volcanoes occur. The lithosphere contains oceanic and continental crust that varies in age and thickness. The lithosphere is the coolest layer of the Earth in terms of temperature, pressure.

Asthenosphere

The **asthenosphere** is the plastic part of the earth just below the lithosphere, including the upper mantle. The depth of the asthenosphere varies and has an average depth of between 100 -660km. As temperatures rise with depth, rocks reach temperatures that would cause them to melt if they were at the surface. The rocks remain solid at depth despite their temperature because of the extreme pressures acting upon them. However, they do become plastic. Subjected to immense forces, and with vast amounts of time, such rocks will flow.

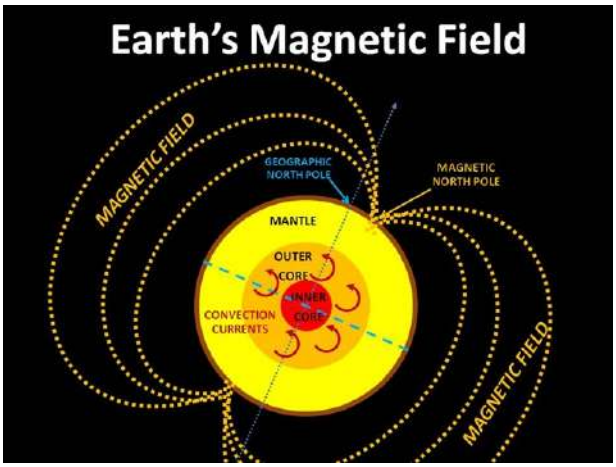


Some solids display this property of solid creep, or flow, even at the surface. Think, for example, of chocolate, which in a warm room may flow and deform without melting. Substances like plasticine (silly putty) will also flow under gravity, especially when warm. Asphalt, used for roads, can be brittle when struck with a hammer, but still flow very slowly, just as ice does when a glacier moves downhill.

Mesosphere

The **mesosphere** refers to the lower portion of the mantle under the lithosphere and the asthenosphere, but above the outer core. The estimated depth of the mesosphere is between 660-2,900 km. The mesosphere is solid and like the asthenosphere, is plastic and able to flow. The rate of flow is slower than rates found in the asthenosphere due to the increasing pressure. This layer should not be confused with the atmospheric mesosphere. Convection in the mesosphere and asthenosphere causes the Earth's plates to move.

Outer Core



The **outer core** is composed mostly of liquid iron and nickel. The outer core reaches between 7,200 and 9,000 degrees Fahrenheit (4,000 and 5,000 degrees Celsius) and is estimated depth to be between 2,900-5150 km. It is the movement of the liquid outer core, called convection currents, that generates Earth's magnetic field.

Inner Core

The **inner core** is the solid metal center of the It has the highest temperatures between 9,000 and 13,000 degrees Fahrenheit (5,000 and 7,000 degrees Celsius). It also has the highest pressures. This solid layer is smaller than our Moon at 750 miles (1,200 km) thick at a depth of 5150- 6,371 km and is composed mostly of iron. The iron is under so much pressure from the overlying planet that it cannot melt and stays in a solid-state.