

Unit 4: Formation of the Earth

Objectives:

E3.2B - Explain how scientists infer that the Earth has internal layers with discernable properties using patterns of primary (P) and secondary (S) seismic wave arrivals.

E3.2d - Explain the uncertainties associated with models of the interior of the Earth and how these models are validated.

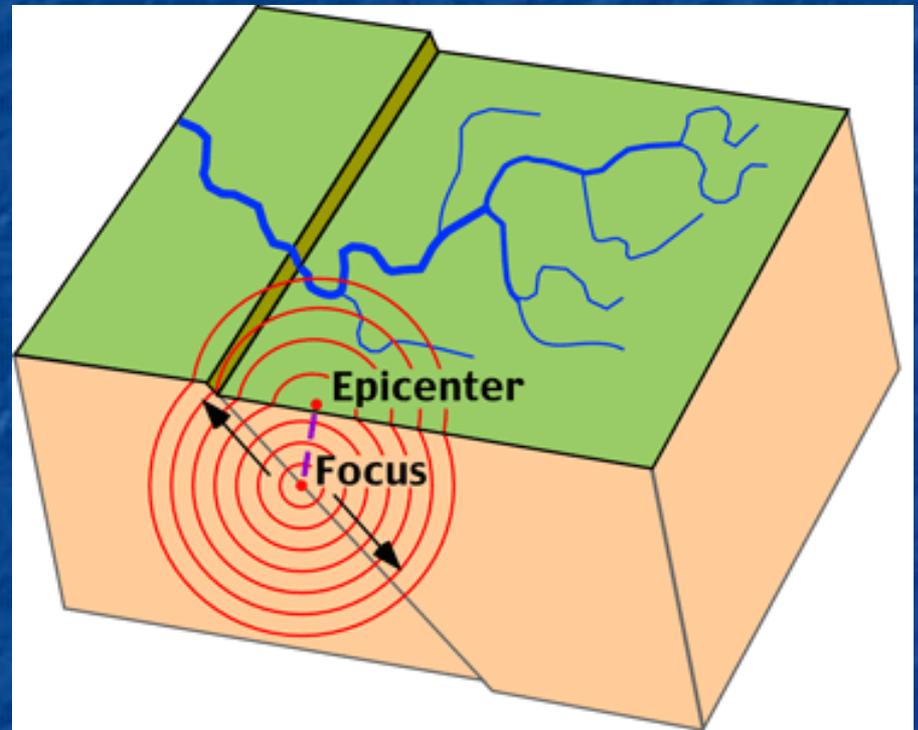
Seismic Waves*

The energy released during an earthquake travels through the Earth in waves. These waves are called **seismic waves**.

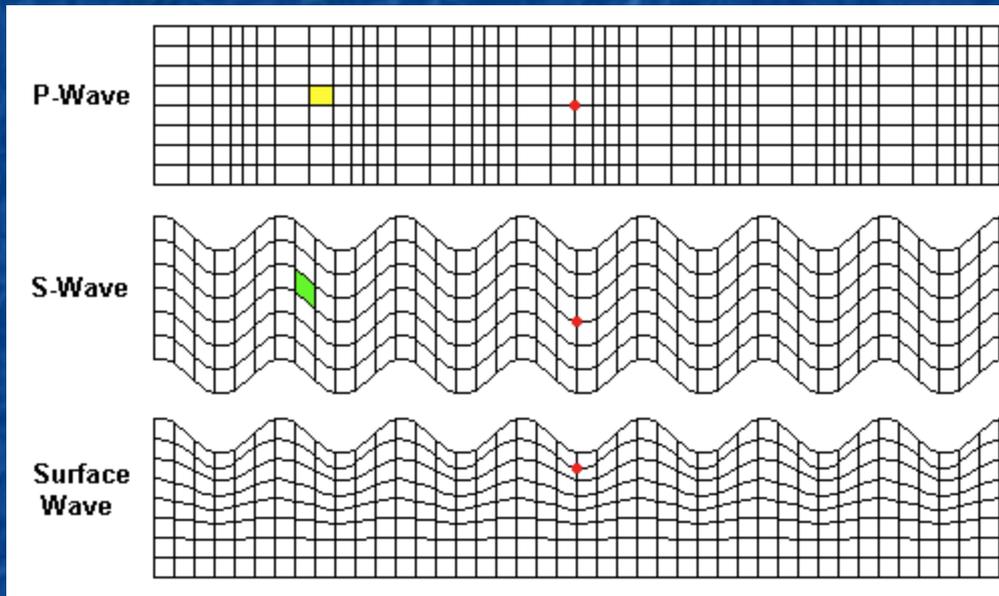
Earthquakes produce three distinct types of seismic waves:

- * Primary (P) waves
- * Secondary (S) waves
- * Surface waves

Primary and Secondary waves (also called body waves) travel in all directions from the earthquake's point of origin (called the **focus**). Surface waves are confined to the upper few hundred miles of the crust. They travel parallel to the surface.



Primary Waves*

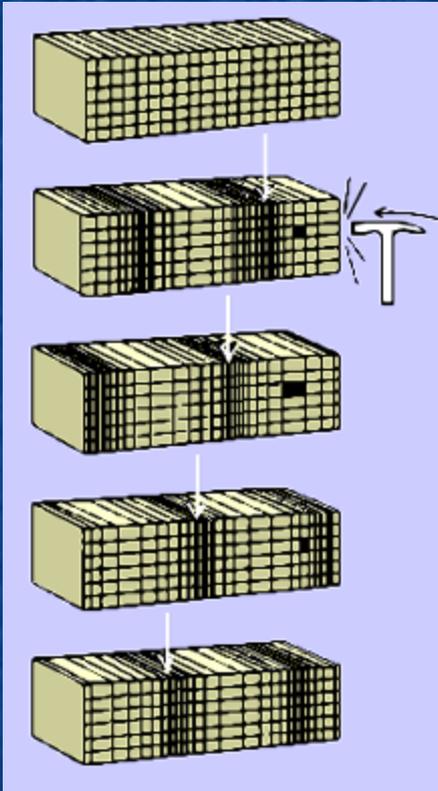


The first type of seismic wave produced by an earthquake is called a compressional **primary wave**, also known as a **P-wave**.

These waves travel through the Earth by compressing and expanding the material through which they pass.

P-waves move like sound waves and vibrate the particles of rock in which they travel.

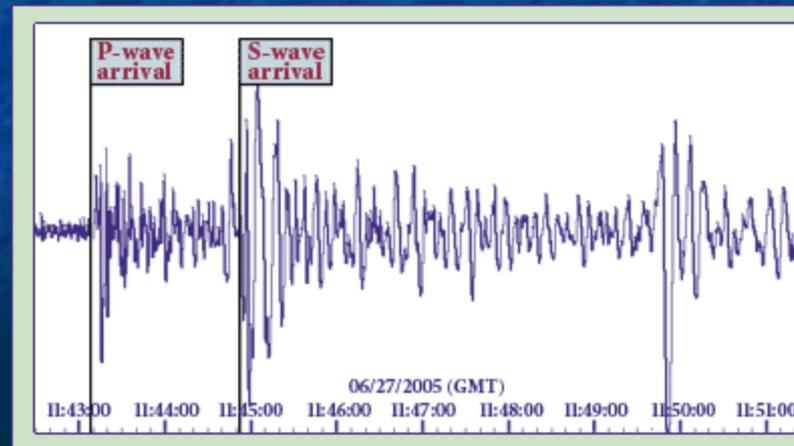
Primary Waves



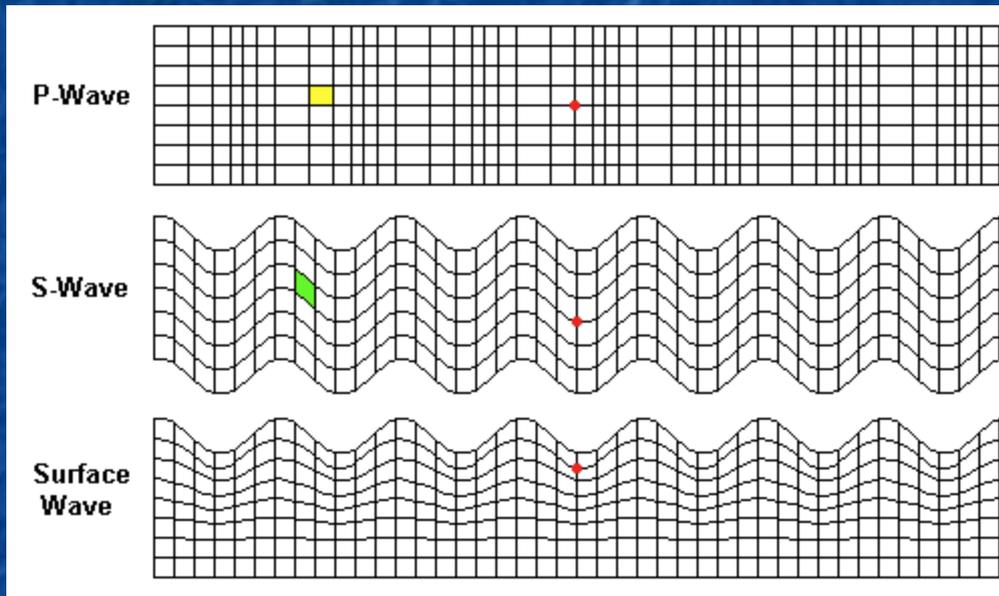
P-waves can travel through solids, liquids, and gases.

P-waves are the fastest type of seismic wave, they are always detected first by a seismograph.

In most rocks, P-waves travel from 1.7 to 1.8 times faster than secondary waves.

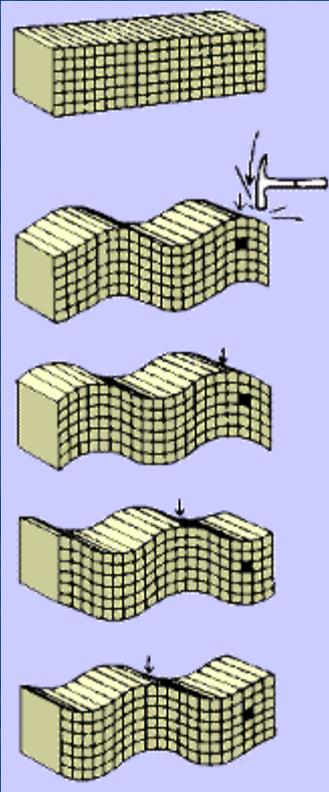


Secondary Waves*

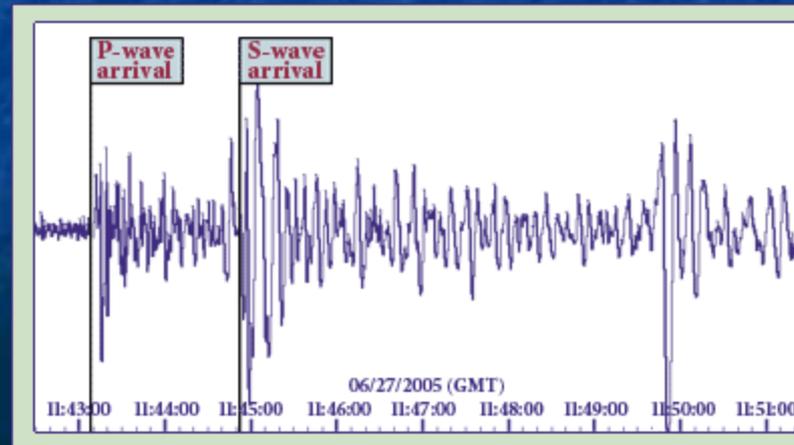


Secondary waves, also known as S-waves, travel through the ground perpendicular to their forward motion, which is in an up-and-down pattern much like the waves that move through water.

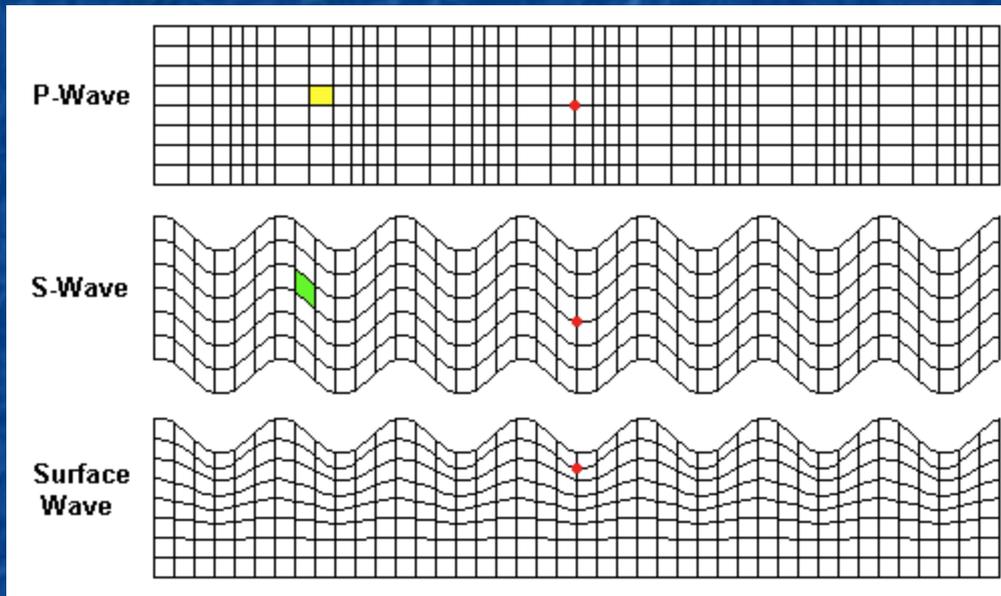
Secondary Waves



S-waves move much more slowly than P-waves and can only travel through solid material, not liquids and gases.



Surface Waves*



Surface waves are produced by a complex interaction of P- and S-waves reaching the Earth's surface. The result is a rolling motion of ground as the surface waves move along the surface of the Earth.

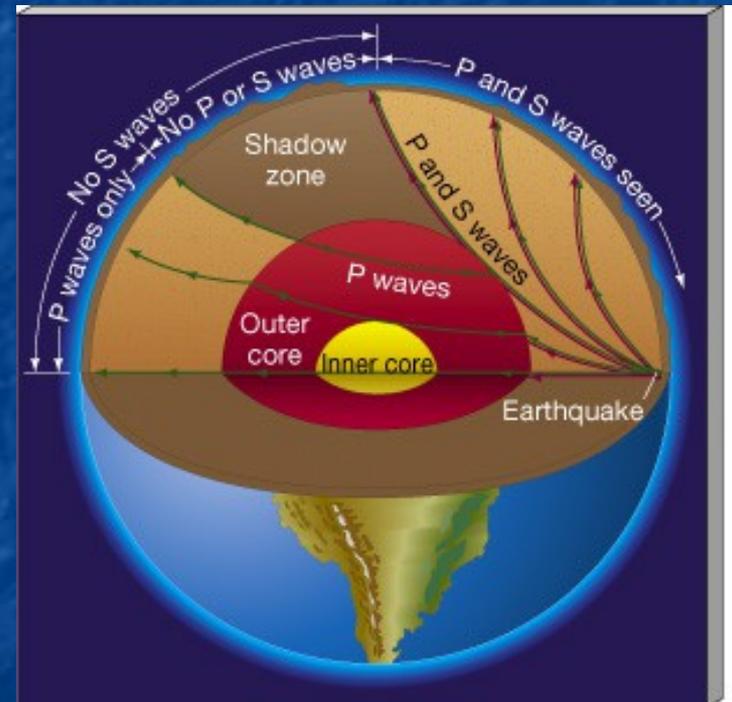
Surface waves are the most destructive of all seismic waves.

Seismic Waves

If humans have never drilled through the crust, then how do we know so much about the layers of the Earth?

We use seismic waves to help us out.

Remember, P-waves can travel through solids, liquids, and gases, while S-waves can only travel through solids. Through studies of earthquakes, we have learned that P-waves pass through the entire Earth, while S-waves can disappear.

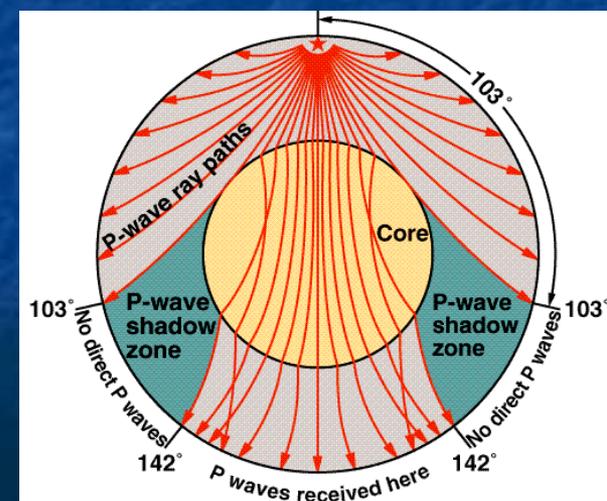
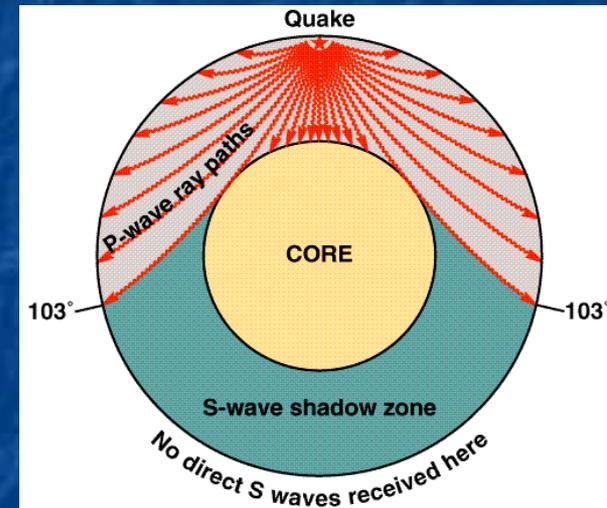


Seismic Waves*

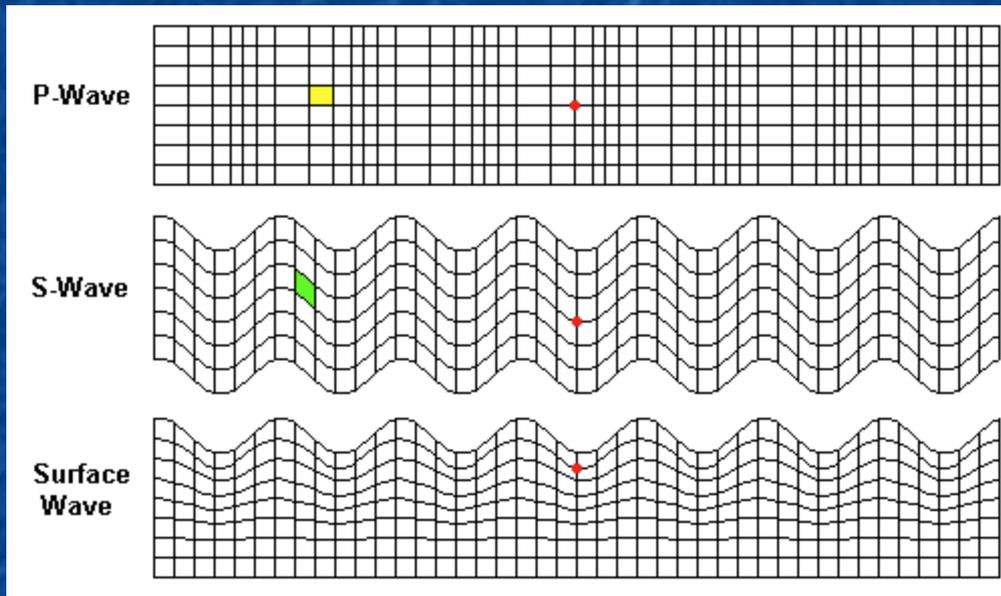
Data from many earthquakes has shown that S-waves disappear when they encounter the liquid outer core.

As seismic waves pass from one type of material into another, they are refracted (or bent slightly).

As a result of these two observations, scientists have determined that all earthquakes have **shadow zones**. These are areas where no seismic waves are received. S-waves are stopped by the liquid outer core, and P-waves are refracted as they enter and leave the liquid outer core.

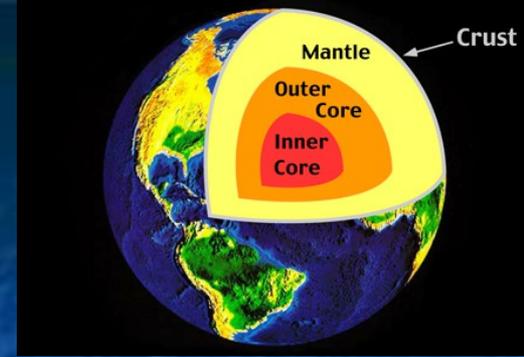


Seismic Waves



Additional data from the study of many earthquakes has shown scientists that the rate at which P-waves and S-waves move depends upon the type and density of the material through which they travel. The velocity of the waves is greatest through material that is less rigid and less dense.

Model Accuracy



All models are subject to inaccuracies. Until humans can somehow drill down into the other layers of the Earth, we will continue to rely on the most accurate data we can to create our models.

At this point, the most accurate data continues to be data obtained from earthquake seismic waves. As more seismographs are put in place, and more data is reviewed, scientists will continue to verify current beliefs about the interior layers of our planet, and they will adjust them as needed.

