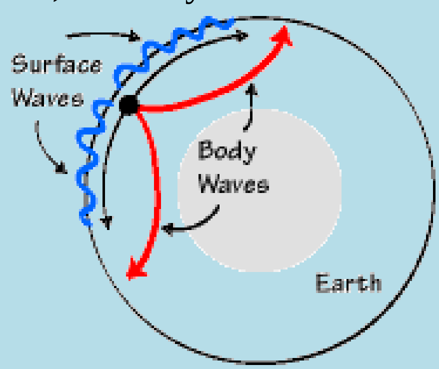
SEISMIC WAVES

Seismology is the study of earthquakes and seismic waves that move through and around the earth. A seismologist is a scientist who studies earthquakes and seismic waves. Seismic waves can be defined as, “the waves of energy caused by the sudden breaking of rock within the earth or an explosion”[1]. They are the energy that travels through the earth and is recorded on seismographs.

Types of Seismic Waves

There are several different kinds of seismic waves, and they all move in different ways. The two main types of waves are body waves and surface waves. Body waves can travel through the earth's inner layers, but surface waves can only move along the surface of the planet like ripples on water. Earthquakes radiate seismic energy as both body and surface waves. Recordings of seismic waves from earthquakes led to the discovery of the earth's core and eventual maps of the layers of the Earth's inside. Just as the prism below refracts light at its faces, seismic waves bend, reflect and change speed at the boundaries between different materials below the Earth's surface[2].



Body and surface waves

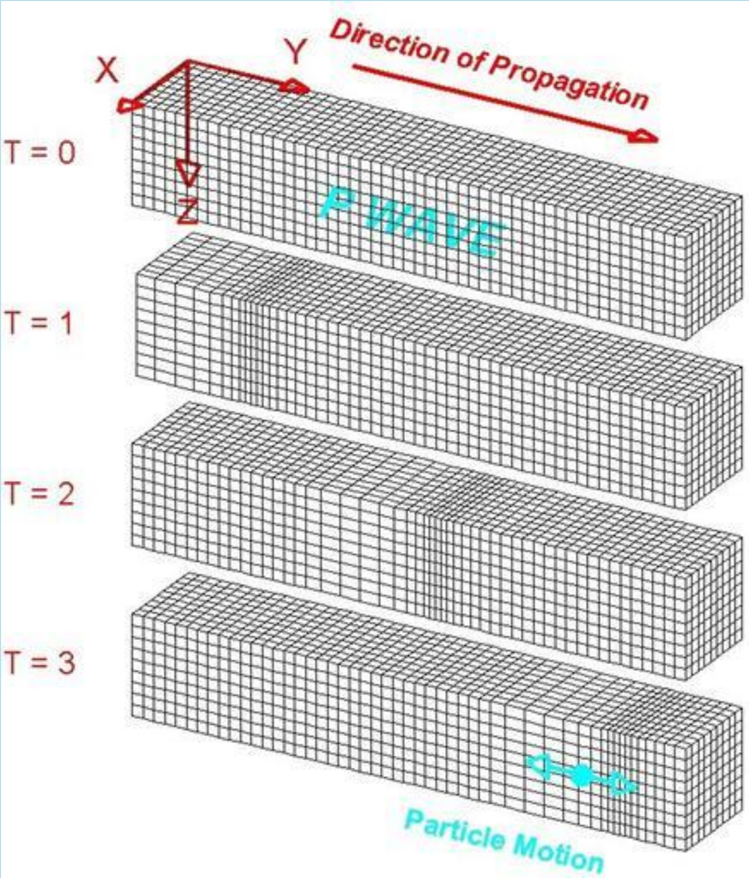
Source: http://eqseis.geosc.psu.edu/~cammon/HTML/Classes/IntroQuakes/Notes/waves_and_interior.html

Body Waves

Traveling through the interior of the earth, body waves arrive before the surface waves emitted by an earthquake. These waves are of a higher frequency than surface waves.

P Waves

The first kind of body wave is the P wave or primary wave. This is the fastest kind of seismic wave, and, consequently, the first to 'arrive' at a seismic station. The P wave can move through solid rock and fluids, like water or the liquid layers of the earth. It pushes and pulls the rock it moves through just like sound waves push and pull the air. Have you ever heard a big clap of thunder and heard the windows rattle at the same time? The windows rattle because the sound waves were pushing and pulling on the window glass much like P waves push and pull on rock. Sometimes animals can hear the P waves of an earthquake. Dogs, for instance, commonly begin barking hysterically just before an earthquake 'hits' (or more specifically, before the surface waves arrive). Usually people can only feel the bump and rattle of these waves.



A P wave travels through a medium by means of compression and dilation. Particles are represented by cubes in this model. *Image ©2000-2006 Lawrence Braile*

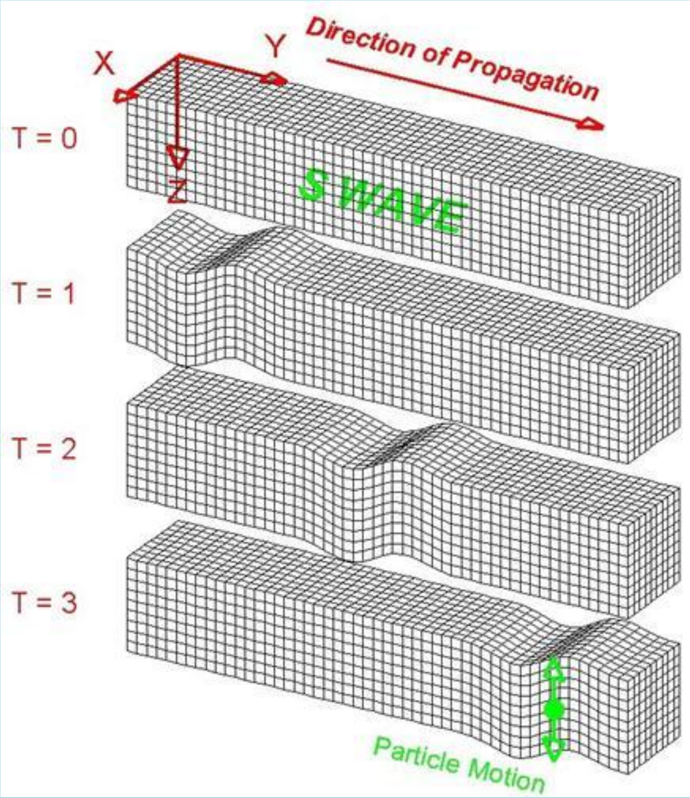
P waves are also known as compressional waves, because of the pushing and pulling they do. Subjected to a P wave, particles move in the same direction that the wave is moving in, which is the direction that the energy is traveling in, and is sometimes called the 'direction of wave propagation.

S Waves

The second type of body wave is the S wave or secondary wave, which is the second wave you feel in an earthquake. An S wave is slower than a P wave and can only move through solid rock, not through any liquid medium. It is this property of S waves that led seismologists to conclude that the Earth's outer core is a liquid. S waves move rock particles up and down, or side-to-side perpendicular to the direction that the wave is traveling in (the direction of wave propagation).

Surface Waves

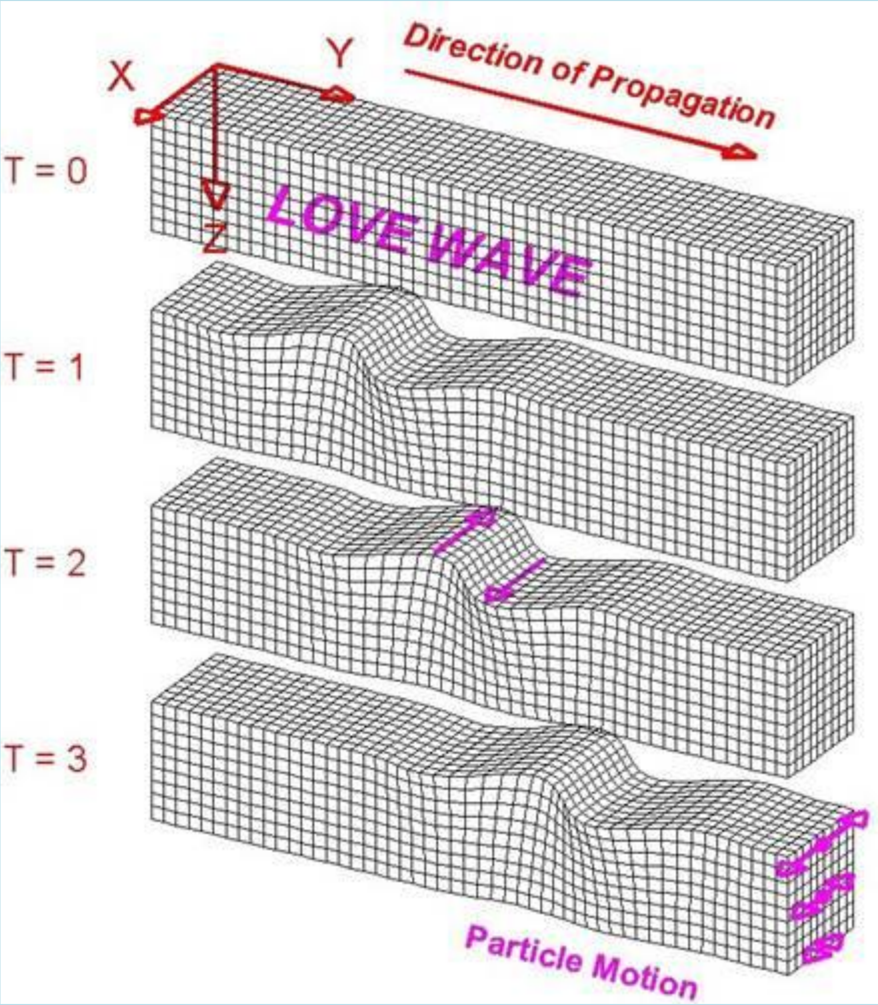
Travelling only through the crust, surface waves are of a lower frequency than body waves, and are easily distinguished on a seismogram as a result. Though they arrive after body waves, it is surface waves that are almost entirely responsible for the damage and destruction associated with earthquakes. This damage and the strength of the surface waves are reduced in deeper earthquakes.



An S wave travels through a medium. Particles are represented by cubes in this model. *Image ©2000-2006 Lawrence Braile*

Love Waves

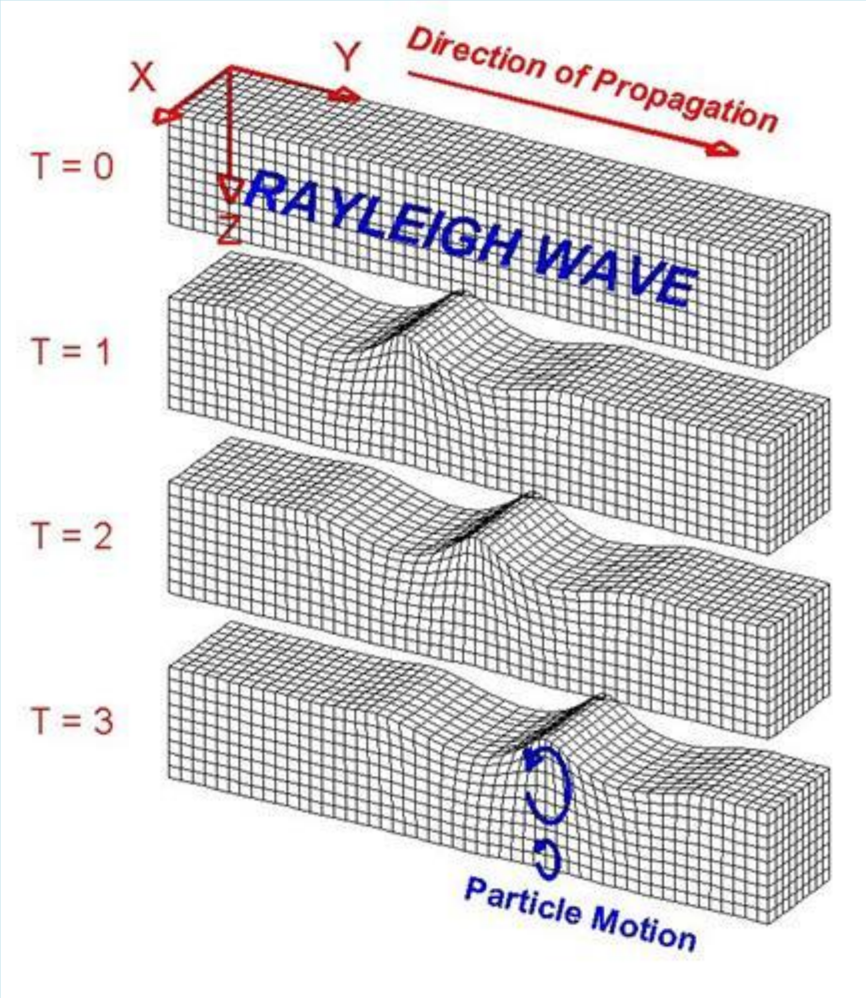
The first kind of surface wave is called a Love wave, named after A.E.H. Love, a British mathematician who worked out the mathematical model for this kind of wave in 1911. It's the fastest surface wave and moves the ground from side-to-side. Confined to the surface of the crust, Love waves produce entirely horizontal motion.



A Love wave travels through a medium. Particles are represented by cubes in this model. *Image ©2000-2006 Lawrence Braile*

Rayleigh Waves

The other kind of surface wave is the Rayleigh wave, named for John William Strutt, Lord Rayleigh, who mathematically predicted the existence of this kind of wave in 1885. A Rayleigh wave rolls along the ground just like a wave rolls across a lake or an ocean. Because it rolls, it moves the ground up and down and side-to-side in the same direction that the wave is moving. Most of the shaking felt from an earthquake is due to the Rayleigh wave, which can be much larger than the other waves.



A Rayleigh wave travels through a medium. Particles are represented by cubes in this model. *Image ©2000-2006 Lawrence B*

Seismic Wave Speed

Seismic waves travel fast, on the order of kilometers per second (km/s). The precise speed that a seismic wave travels depends on several factors; most important is the composition of the rock[3]. Temperature tends to lower the speed of seismic waves and pressure tends to increase the speed. Pressure increases with depth in Earth because the weight of the rocks above gets larger with increasing depth. Usually, the effect of pressure is larger and in regions of uniform composition, the velocity generally increases with depth, despite the fact that the increase of temperature with depth works to lower the wave velocity.

References

[1] http://www.geo.mtu.edu/UPSeis/waves.html
[2]http://www.colorado.edu/physics/phys2900/homepages/Marianne.Hogan/waves.html
[3]http://eqseis.geosc.psu.edu/~cammon/HTML/Classes/IntroQuakes/Notes/waves_and_interior.html